

AUTOMOBILE ENGINEER

DESIGN • PRODUCTION • MATERIALS

Vol. 48 No. 1

JANUARY 1958

PRICE: 3s. 6d.



FBC SPECIALS

... the key to a fuller life

There are many designs in which an FBC 'Special' has saved the situation.

Sometimes new developments take such a form that standard bearings will not fit in; in other cases performance has been stepped up to such a pitch that the original standard bearings are no longer man enough for the job.

That is where FBC 'Specials' come in. Special sizes of bearings can be produced to suit the restricted space available: Or bearings of standard dimensions can be developed to carry loads—or to cope with speeds—far above those within the capacity of the standard bearings.

It is amazing what exacting duties can be carried out by the right kind of bearing, when one is really 'up against it' and enlists the aid of the right people.

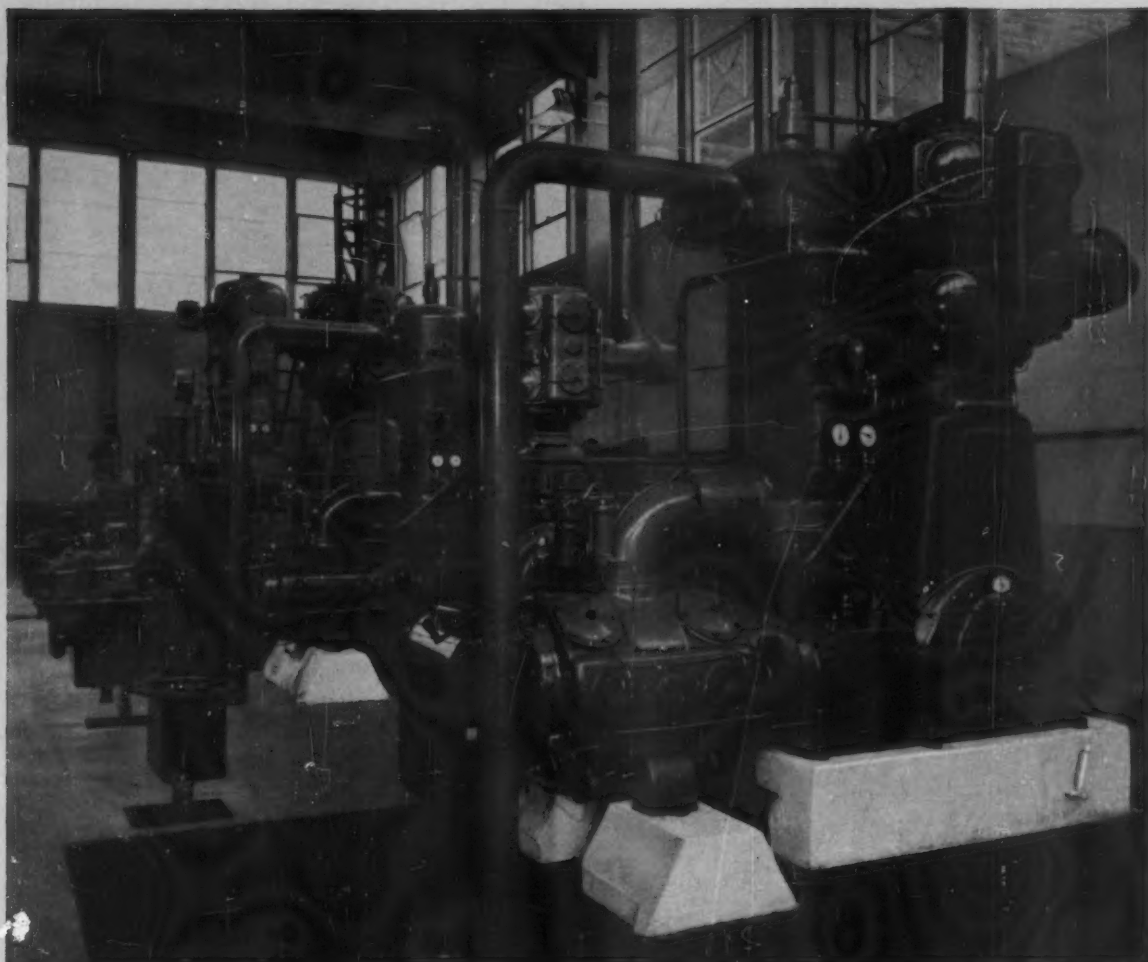
Our engineers—to whom, of course, we have just referred—will always assist in the design and manufacture of 'Specials' to suit customers' problems.

FISCHER BEARINGS CO. LTD., WOLVERHAMPTON

Fischer Bearings Company Ltd., and Timken-Fischer Stockists Ltd., Birmingham, are both subsidiaries of British Timken Ltd.

FBC FISCHER
Regd. Trade Marks

FBC
TRADE MARK
ALL-BRITISH
BALL AND
PARALLEL-ROLLER BEARINGS
F.B.C. WOLVERHAMPTON



Atlas Copco compressors provide air for British car body firm

When the new 400,000 sq. ft. Swindon plant of Britain's Pressed Steel Company Limited was planned, the compressor installation was naturally of prime importance. Two Atlas Copco AR7 compressors were installed and have been running trouble free, nine hours a day, 5 days a week since January 1956 and an AR9 has recently been installed to meet the steadily increasing demand.

They supply compressed air, first, for the clutch control and balancing of power presses ranging up to 1,000 tons capacity; second, for the spot welding guns and other air tools in the Company's machine shop.

At 100 lbs/sq. in. the free air delivery of the 318 hp AR7 is 1,740 cfm. The output of the 586 hp AR9 is 3,210 cfm.

This means that only 18.3 hp is required for every 100 cu. ft. of air delivered per minute at 100 lbs/sq. in., and this extremely high efficiency has impressed industrial planners not only at the Pressed Steel Company but throughout the world.

WORLD-WIDE SALES AND SERVICE

The Atlas Copco Group puts compressed air to work for the world. It is the largest group of companies specialising solely in the development and manufacture of compressed air equipment. It embraces Atlas Copco companies or agents manufacturing or selling and servicing Atlas Copco equipment in ninety countries throughout the world. For further details, contact your local Atlas Copco Company or Agent, or write to Atlas Copco AB, Stockholm 1, Sweden, or Atlas Copco (Great Britain) Limited, Beresford Avenue, Wembley, Middlesex.

Atlas Copco *Manufacturers of Stationary and Portable Compressors, Rock-Drilling Equipment, Loaders, Pneumatic Tools and Paint-Spraying Equipment.*

c99

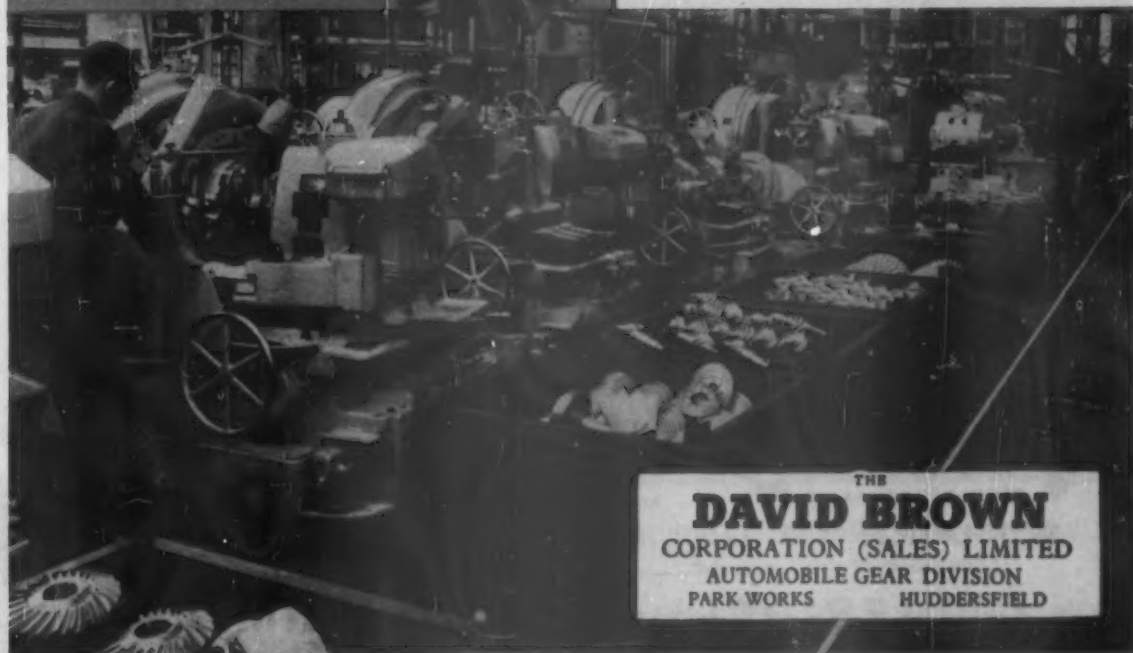
HYPOID & SPIRAL BEVEL GEARS

OF PRECISION AND PERFORMANCE.

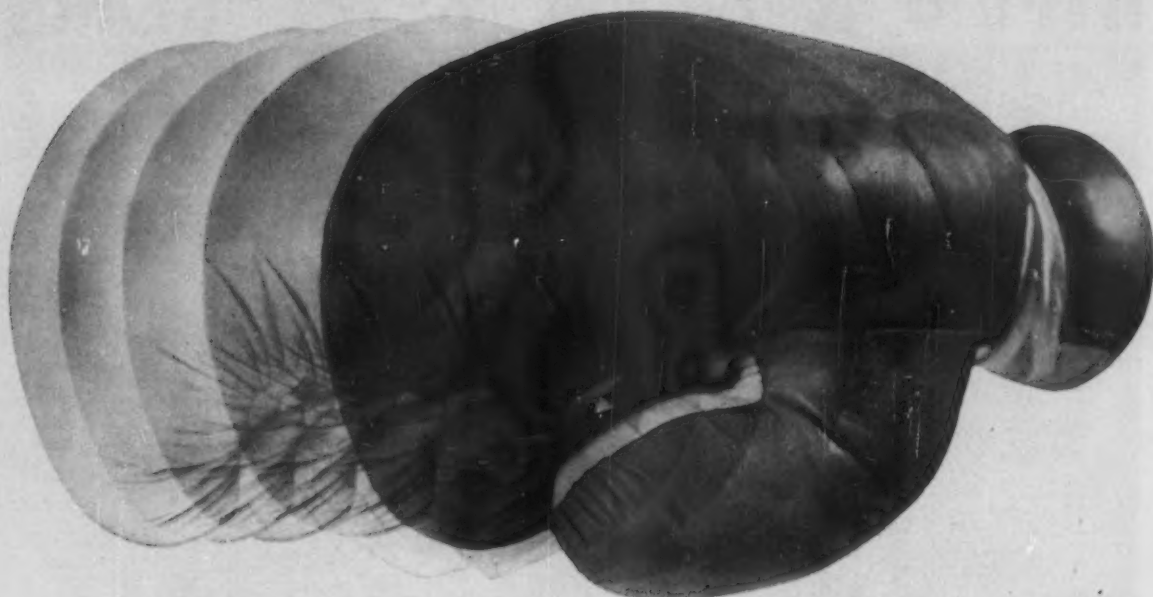


*For every type and size
of automobile transmission
in either small or
large quantities
specify*

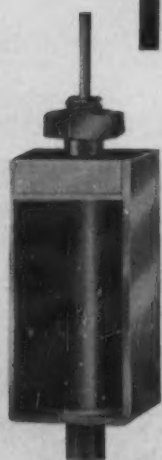
"GEARS BY DAVID BROWN"



**THE
DAVID BROWN**
CORPORATION (SALES) LIMITED
AUTOMOBILE GEAR DIVISION
PARK WORKS HUDDERSFIELD



1000 times a minute!



The Varley S.M.O. solenoid is the first of a range of miniature solenoids being developed for the electronic and accounting machine industries.

It can operate about 1000 times a minute through $\frac{1}{8}$ in.

Varley make Solenoids of all shapes and sizes

to push or pull anything from ounces to thousands of pounds.

If you need to push, pull, press, prod or punch—*by remote control*—investigate the applications of Varley Solenoids.

They are 100% British in design and manufacture.

For full details of Varley Solenoids send this coupon

**OLIVER PELL CONTROL LTD.
CAMBRIDGE ROW, WOOLWICH, S.E.18**

- ☐ Please send me illustrated booklet "VARLEY SOLENOIDS"
☐ Please arrange for a technical representative to call on me

NAME _____

COMPANY _____

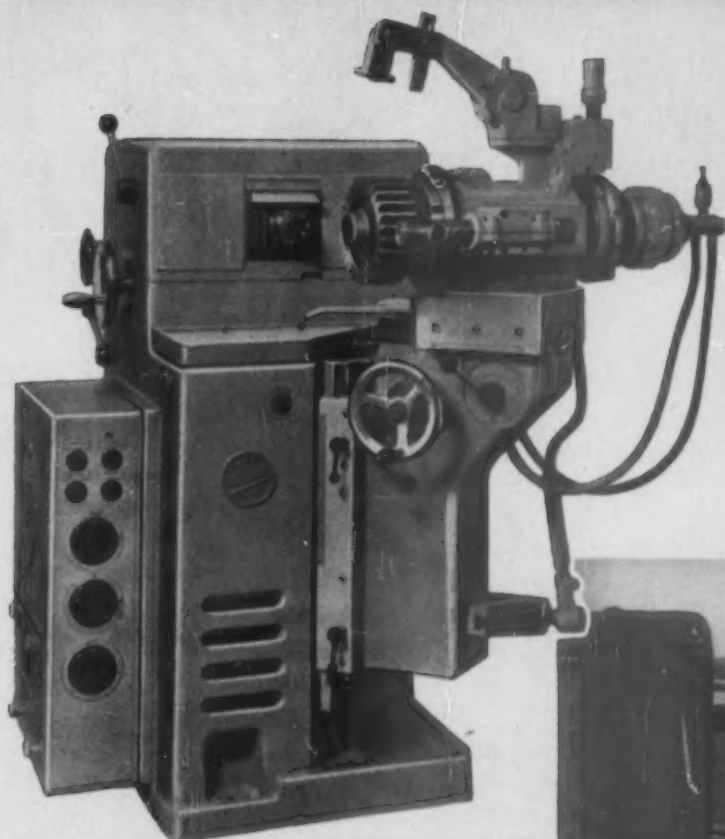
ADDRESS _____

A.E.

Varley
REGD. TRADE MARK
WOOLWICH 1422

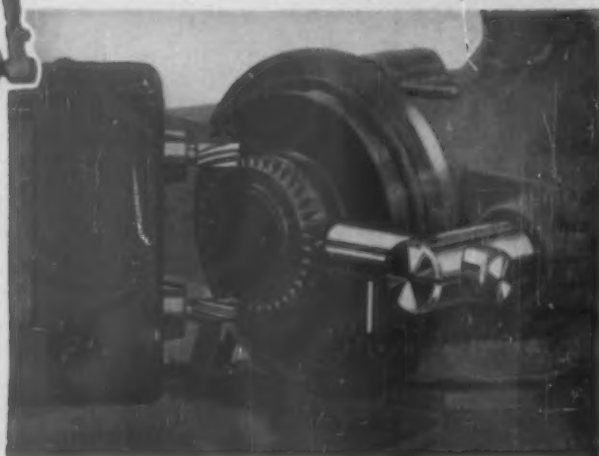
OLIVER PELL CONTROL LIMITED

HURTH **AUTOMATIC**



GEAR TOOTH ROUNDING & DE-BURRING MACHINES

• **TWO-SPINDLE HEAD AVAILABLE
FOR VOLUME PRODUCTION**



Fast approach of bell-type cutter, self indexing after reaching pre-set depth and automatic stopping on completion of cycle, make the HURTH Model ZK4 an ideal machine for batch work on spur and helical gears, starter rings, clutches, etc. Maximum work-piece dia.: 12". Range of teeth rounded: chamfered or de-burred 25-6 D.P., 7-110 teeth per gear. Speeds up to 120 teeth per minute.

LET US DEMONSTRATE TO YOU.

**VAUGHAN
ASSOCIATES LIMITED**

4, QUEEN STREET, CURZON STREET, LONDON, W.1

Telephone : GROSVENOR 8362-5

Midland Office: WILFORD CRESCENT, NOTTINGHAM

Telephone : NOTTINGHAM 89098.

Rainbow



short-handed?

Only *one* pair of hands is required to operate the Azoflex model 42/63 to produce prints in large quantity—dried, flat and ready for immediate trimming and collating. No darkroom, no elaborate ventilating system and ducting are necessary as there are no unpleasant fumes, and therefore AZOFLEX machines are completely mobile to facilitate reorganisation or expansion. Exposing, developing and print delivery are all synchronised for an even flow of finished work, and output in excess of 100 20"×30" prints per hour can easily be achieved. AZOFLEX is the *only*

daylight reflex copying process and it is the *only* photoprinting process to apply a measured dose of developer, thus ensuring optimum quality.

The majority of AZOFLEX photoprinting machines can, subject to certain conditions, be hired as an alternative to outright purchase, where this is preferred.

AZOFLEX MODEL 42/63. Combined synchronised printer and developer. Capacity: cut sheets and rolls up to 42 in. wide. Printing speed: from 6 in. to 15½ ft. per minute. Dimensions: Height 52 in. Width 67½ in. Depth 52 in. with delivery tray extended. Weight: approximately 850 lbs.

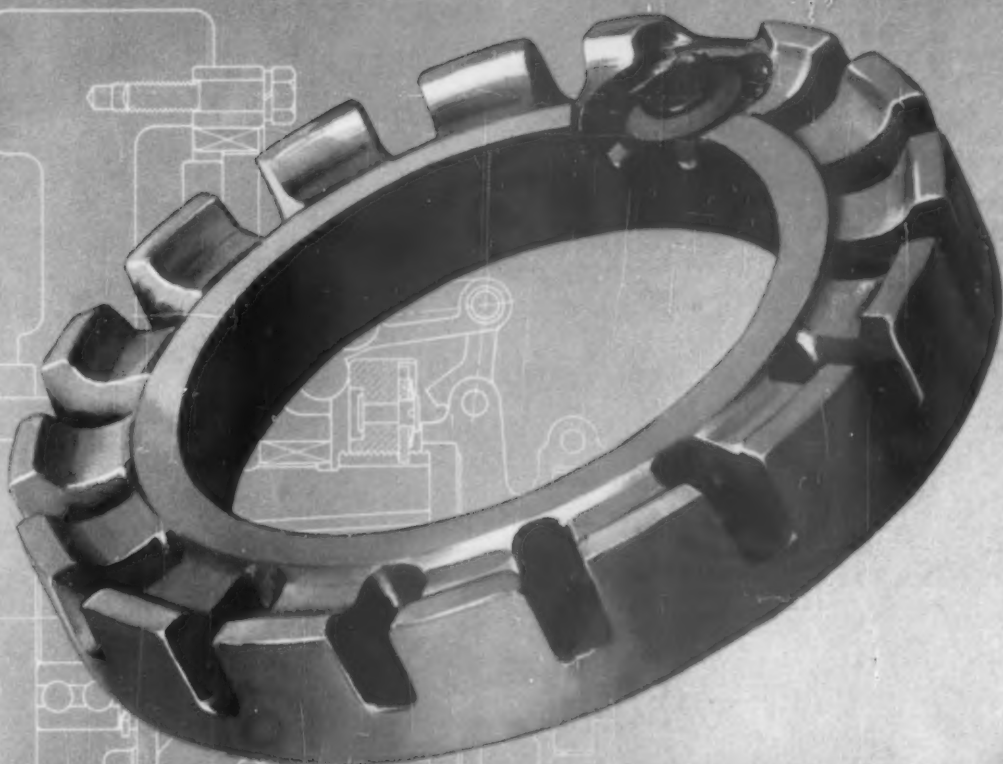


ILFORD

Azoflex

Enquiries to:
Ilford Limited, Azoflex Dept. AZ14C,
104 High Holborn, London, W.C.1
Telephone: HOLborn 3401

MACHINES AND MATERIALS FOR DRAWING OFFICE PHOTOPRINTING



The adjuster

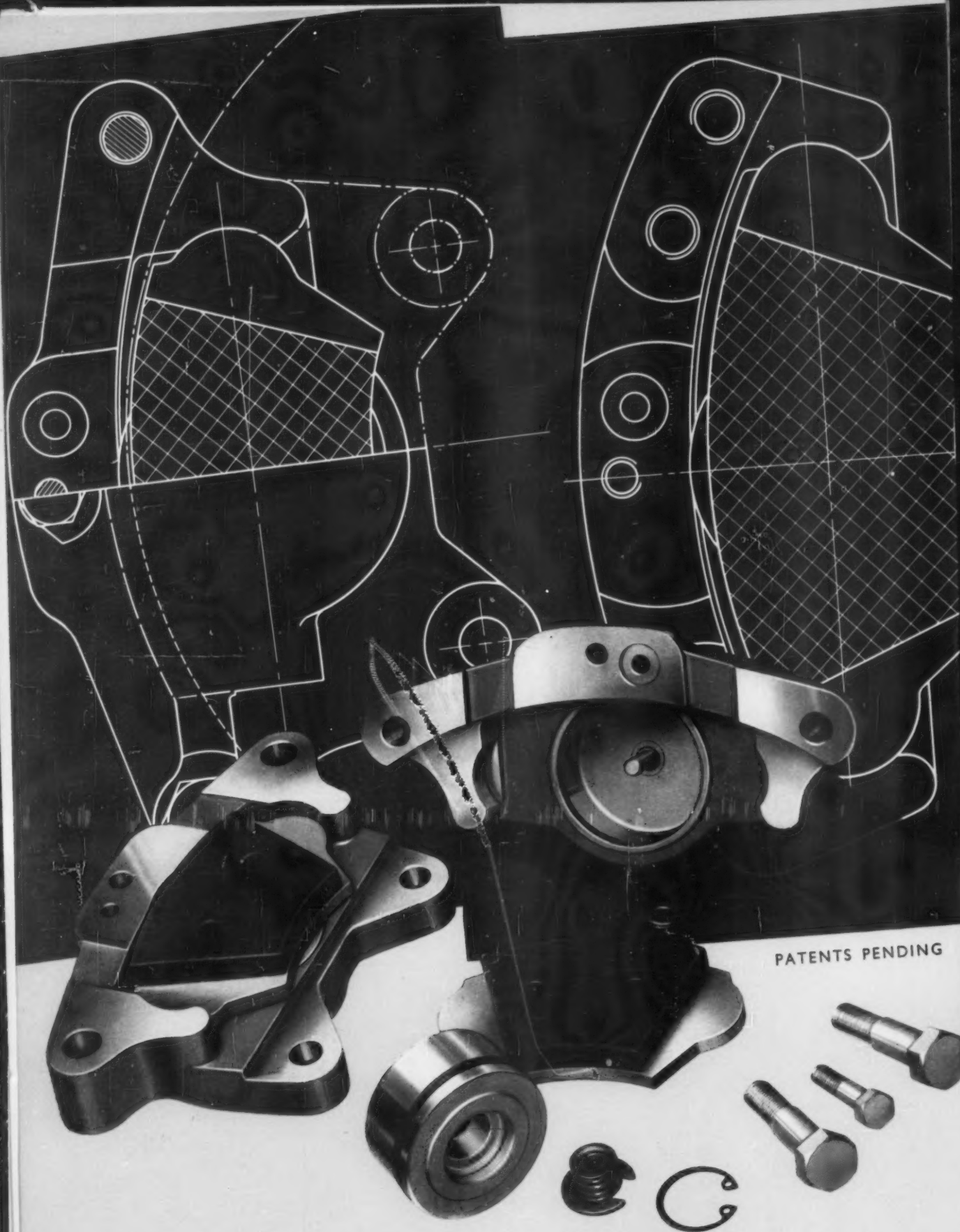
The operating levers of Rockford clutches react against a collar on the fixed plate, and by adjusting this collar, wear of the clutch lining may be taken up in an extremely simple manner without the use of special tools.

An important feature of Rockford clutches is their 'over-centre' action, so that no matter whether the clutch is engaged or disengaged, there is no running thrust. The release bearing therefore only operates during the moments of actual clutch operation.

An alternative type of release bearing contains a ball race. Rockford 'over-centre' clutches are made in a wide range of sizes, from 14 in. to 5½ in.

ROCKFORD

CLUTCHES & POWER TAKE-OFFS



PATENTS PENDING

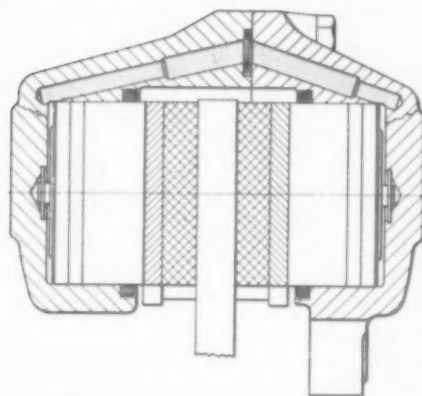
AUTOMOTIVE PRODUCTS COMPANY LIMITED

LOCKHEED *hydraulic* DISC BRAKES

The two sizes 'M' & 'H' cover practically every requirement, with ample sized friction pads that give normal mileage without replacement.

The view of the dismantled brake shows the 'M' type, for discs of 9½ to 11 in. diameter; the friction material is ¾ in. thick, 5½ sq. in. area, as shown (full size) in the left-hand blue-print opposite.

The 'H' type is shown in the second blue-print (also full size) for discs 10 to 12 in. diameter, it has friction pads ½ in. thick and 7½ sq. in. area.



INTERNAL FLUID DUCTING

GENERAL FEATURES.

Constant brake pedal travel throughout the life of the friction pads is provided by the automatic adjusters.

Friction pads are easily changed without disturbing the hydraulic connections.

Reserve of brake lining is clearly visible.

Two pistons; each has a simple and effective Lockheed seal.

Pistons are well-guided and excellent arrangements are made for excluding dirt, dust or water from the hydraulic equipment.

Internal fluid duct with one pressure seal, eliminates the outside pipe and also simplifies installation.

Servo-assistance is available if required, also hand brake mechanism.

LOCKHEED

Registered Trade
Mark: LOCKHEED

The safest disc brake in the world

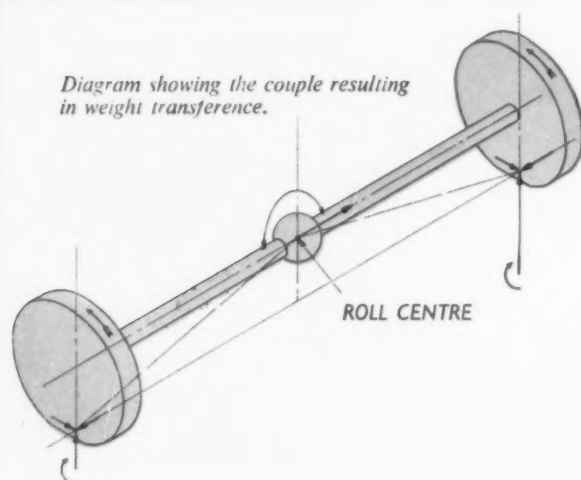
Our engineers would welcome the opportunity of
discussing your future vehicle braking requirements.

LEAMINGTON SPA, WARWICKSHIRE, ENGLAND

MAKING STEERING LIGHTER

Weight transference in cornering

We have seen that as far as parking torque is concerned, i.e. heaviness of steering in low-speed manoeuvring, we can improve it mechanically by providing minimum friction in the steering joints and pivots and maximum efficiency of the steering box, and as far as the tyre is concerned—by increasing the pressure. When the car is on the move, the tyres produce self-aligning torque



and drag-difference torque as a result of the drift angles induced by cornering, and we are now concerned with the effect on these torques of the way in which the weight transference from inner to outer wheels on a corner is shared between front and rear.

Perhaps the best way we can study this for our present purpose is to take an assumed pair of wheels developing a given sideways force and increase the weight transference by stages and see what effect this increase has on the total self-aligning torque from all sources. For this purpose we take again the tyre properties given in the I.Mech.E., A.D., paper "Tyre Characteristics as Applicable to Vehicle Stability Problems", by Hartley & Joy. For an initial load per wheel of 950 lbs. we assume a total cornering force per pair of wheels of 800 lbs. The drift angle of the pair of wheels rises from

4.4° at zero weight transference to 5.4° at 500 lbs. weight transference. The self-aligning torque of the tyres rises from 77 lbs./ft. at zero weight transference to 98 lbs./ft. at 500 lbs. weight transference. With the assumed offset of the wheel plane at the rotational axis of 3" from the king pin, the drag difference effect rises from zero at zero weight transference to 11 lbs./ft. at 500 lbs. weight transference. We have therefore added just over 40% to the total tyre self-aligning torque by our weight transfer of 500 lbs.

Increase of weight transfer at the front is a means of increasing understeer tendency, as the increase in drift angle noted above will imply; we cannot therefore even consider the increase of tyre pressure as a cure of heaviness resulting from increased weight transfer, as the increased tyre pressure would reduce the drift angle which we have been at pains to put up by increasing the weight transference. We can help ourselves a little by various means, but they can only make small differences. We can, for instance, eliminate the Ackermann effect from the steering linkage. This implies that the outside wheel on a corner turns through a greater angle and as the weight is transferred to this wheel on a corner, effectively some extra steering angle is obtained; this however also has an oversteering tendency and may be impossible or at least undesirable because of that.

We can also get a little of our understeer by roll steer effect. It is unwise to overdo this, however, as otherwise the handling behaviour on a straight road with the car unrolled will be considerably different from the cornering handling, and one of the reasons for liking understeer is that it makes the car so much easier to control on a straight road.

Basically, heavier dynamic steering is one of the penalties of understeer, and if we like understeer we must put up with some degree of heaviness as a result.

Thompson

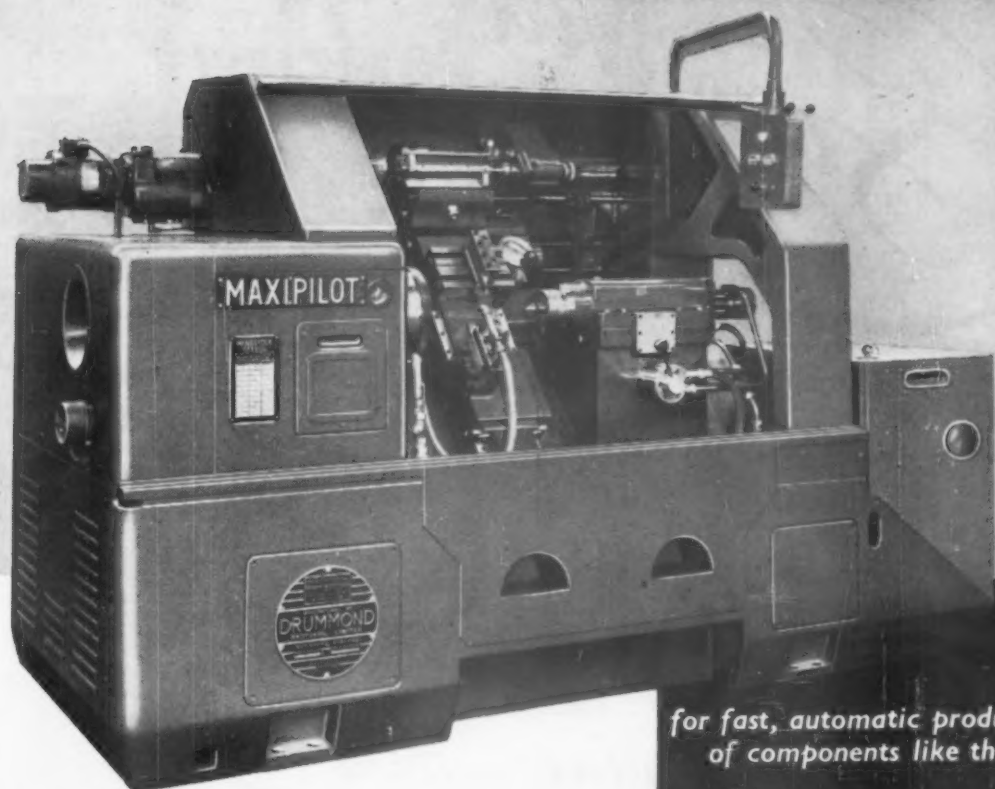
Self-adjusting

STEERING AND SUSPENSION JOINTS

AUTOMOTIVE PRODUCTS COMPANY LIMITED, LEAMINGTON SPA, WARWICKSHIRE, ENGLAND

Introducing the

MAXIPILOT



AUTOMATIC MULTI-CYCLING HYDRAULIC COPYING LATHE

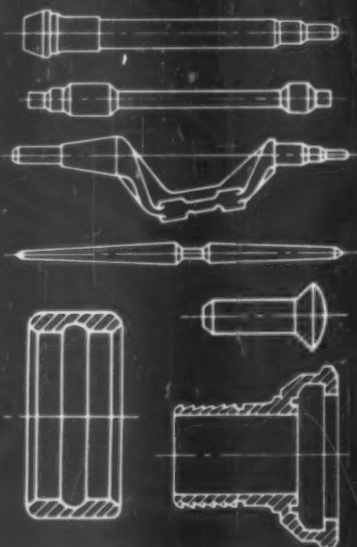
THE MAXIPILOT is an exceptionally rigid and powerful machine designed to exploit to the maximum the cutting possibilities of carbide tools. Round or composite masters are held between centres at the top of the machine clear of swarf and coolant. The template carrier can be automatically indexed by power drive and an eight position longitudinal stop bar rotates with the master and brings in the correct stop for the ensuing machining pass.

The "Maxipilot" is made in two sizes with 20" or 32" between centres and maximum swing of 16" over the bed and 9½" over the cross slide.

Write today for fully descriptive catalogue.

DRUMMOND BROS. LTD.
GUILDFORD • ENGLAND

for fast, automatic production
of components like these



Sales & Service for

DRUMMOND-ASQUITH

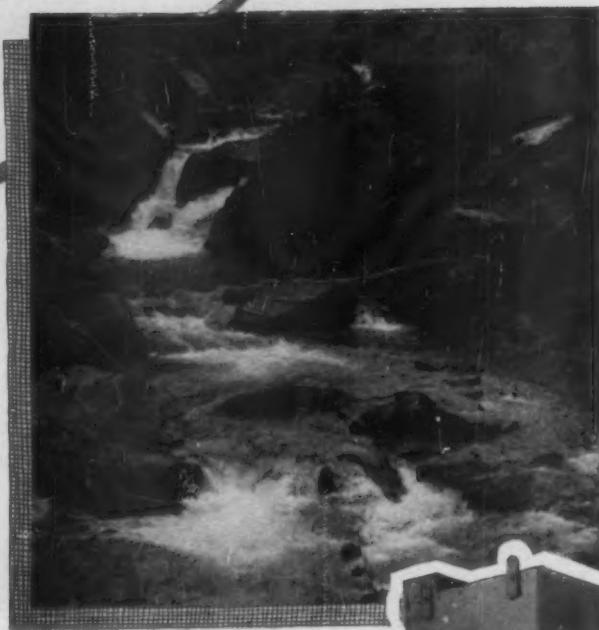
the British Isles

DRUMMOND-ASQUITH (SALES) LTD., KING EDWARD HOUSE, NEW ST., BIRMINGHAM

'Phone: Midland 3431 (7 lines) 'Grams: Maxishape, B'ham.

Also at LONDON: Phone: Trafalgar 7224 (5 lines) and GLASGOW: 'Phone: Central 3411

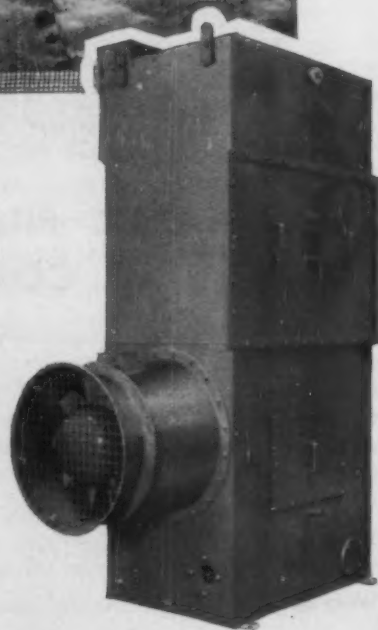
Save Water



Utmost Saving with **HEENAN WATER COOLERS**

In any process in which heat must be removed by water, very attractive financial savings can be secured by continuously re-cooling and re-circulating the water.

Consult us on your needs.



HEENAN & FROUDE LTD :: WORCESTER :: ENGLAND



Holroyds help you to keep the wheels turning by holding on call for immediate delivery worm reducers in no less than 340 combinations of size, ratio and type.

Holroyd HU	Single reduction underdriven with horizontal input and output shafts. Centre distances 3, 4, 5, 6, 7, 8, 9, 10 and 12 inches.
Holroyd HO	Single reduction overdriven with horizontal input and output shafts. Centre distances 3, 4, 5, 6, 7, 8, 9, 10 and 12 inches.
Holroyd HV	Single reduction with vertical output shaft and horizontal input. Centre distances 3, 4, 5, 6, 7, 8, 9, 10 and 12 inches.
Holroyd Verso	2½ inch centre distance. Suitable for underdriven, overdriven or side mounting.
Holroyd F	Made in three sizes—1½, 1½ and 2½ inch centre distance, and suitable for a variety of mounting positions.
All the above are available with any of the following ratios:—5, 7½, 10, 15, 20, 25, 30, 40, 50, 60 and 70 to 1.	

In addition to these gear boxes constantly held in stock, there are other types and sizes (up to 24 inch centre distance) most of which can be built up for you fairly quickly. Send for the 50 page book about Holroyd worm speed reducers and you will always have complete details of the whole range by you for quick reference.

Holroyd

90 YEARS OF GEARS

JOHN HOLROYD & CO. LTD., MILNROW, LANCASHIRE
CNC 18g

Unique



"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatigue than bolts or studs made by the usual method.

G. P. Newall & Co., Ltd.

POSSILPARK GLASGOW • N



General type
(triangular flange)



Pedestal assembly



Pedestal mounting



Frustacon type



FN type



Instrument type
(pedestal flange)



Instrument type (square flange)



Ring-stud
mounting



Bonded stud
mounting

VIBRATION-FREE

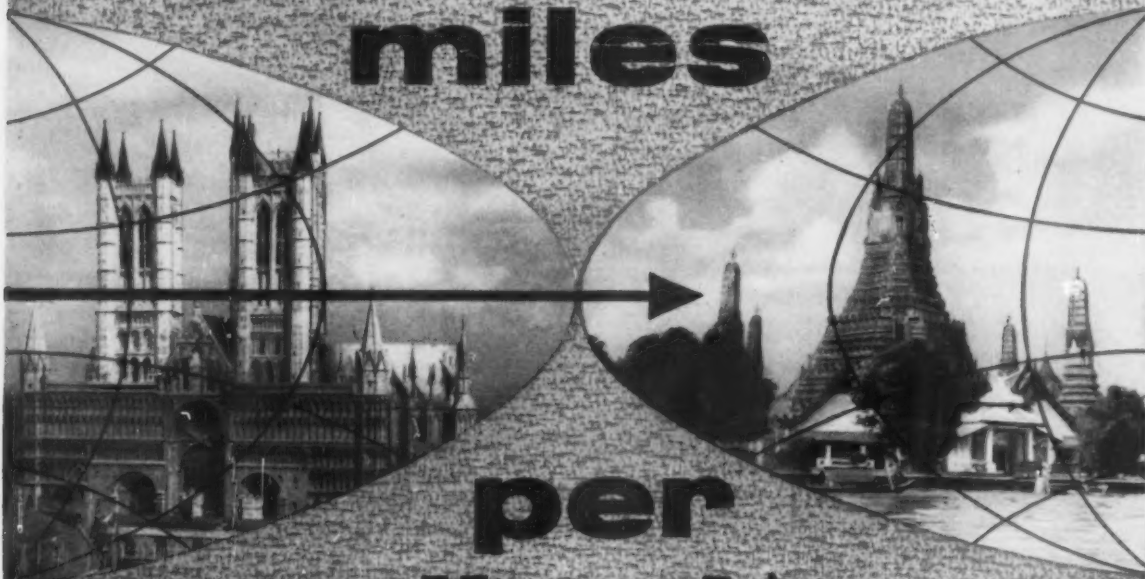
'SILENTBLOC' rubber-metal mountings are the accepted means of insulating almost anything from vibration—from small and delicate instruments to multi-ton drop-hammers. If you have a vibration problem, bring it to us as pioneers and far and away the leaders in the use of rubber in engineering. Technical information always available from *Silentbloc Limited, Manor Royal, Crawley, Sussex. Telephone: Crawley 2100.*

MOUNTINGS by SILENTBLOC

ANDRE RUBBER CO. LTD. — A SILENTBLOC COMPANY

Pioneers of Rubber in Engineering

8000 miles



per gallon!*

**Yet these low-consumption
'CD' lubricators give an adequate
and constant oil supply
to every chassis bearing**

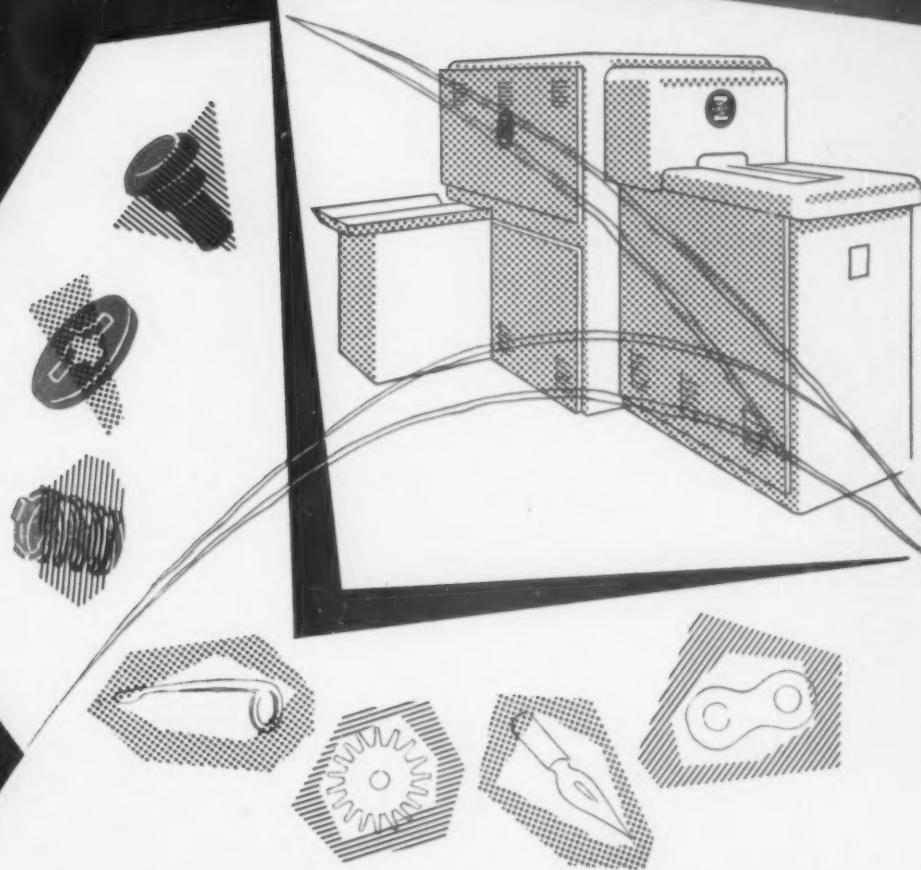
And this supply through individual pressure feed lines extends the life of each bearing by up to ten times. This saving is reinforced by reduced labour costs and cuts in wastage and time. Thousands of discriminating operators attest to the worth of these ingenious machines which are available for feeding from 24 to 72 points. Distributors in your area are available for installations. Specify for your new vehicles. Please write for further details



*average consumption for single-headed 24 or 36 point Clayton Dewandre
Multipoint* chassis lubricators.*

Clayton Dewandre Automatic Chassis Lubricators

CLAYTON DEWANDRE CO. LTD. TITANIC WORKS, LINCOLN, ENGLAND. TEL: LINCOLN 11305-9



PRODUCTION HARDENING FURNACES

Designed for the continuous hardening of relatively small components, the Birlec shaker hearth furnace ensures uniformity and reproducibility of results, neither of which can be guaranteed by batch methods. Thermal efficiency is high since the hearth plate, unlike a continuous conveyor, remains permanently within the heated zone.

The unit produces clean work of the highest quality and ensures complete freedom from decarburisation and distortion. If required, fully automatic quenching and work handling gear can be provided, rendering the unit completely automatic.

More than 100 Birlec shaker hearth furnaces are now engaged throughout the world in the production hardening of spring clips, screws, pins, bolts, bearing rings and similar components.

BIRLEC LIMITED

An A.E.I. Company

ERDINGTON • BIRMINGHAM 24



LONDON • SHEFFIELD
GLASGOW • NEWCASTLE-ON-TYNE

SM/B 3018H



I gather Ransome & Marles have a substantial export trade?

Yes. Business overseas has been done for many years

through agents and subsidiary companies. Among our biggest customers are many of the newly industrialised countries in Africa and the Far East—countries which are now equipping themselves with machinery at an enormous rate. We also export our bearings to the established industrial areas—to Europe and North America—where our products enjoy a long record of first-class service.

You have, of course, a worldwide network of agents to support this export trade?

We have indeed. Something like eighty agency offices throughout the world. We are concerned, mainly, with providing an unrivalled on-the-spot service for overseas industry. Firstly, we produce bearings that will stand up to arduous conditions of work in every climate. Secondly, local users are thoroughly informed about all the factors affecting the actual running of the bearings. Thirdly, the purchaser is safeguarded with after-sales service. These are our obligations to the foreign manufacturer. I think it is fair to say that we meet them very successfully, because we are constantly expanding our export business and shall continue to do so in the future.

RANSOME & MARLES BEARING CO. LTD • NEWARK-ON-TRENT • ENGLAND

TELEPHONE • NEWARK 456 AND TELEX 37-306



* This makes sense

— Please check

Who buys tool bits

MP

for your shop?



Here are some things he should know

No tool bits can be better than the steel they're made from

'Eclipse' tool bits are made from H3 cobalt high speed steel, melted, heat treated and finished under one control to strict and rigid standards of quality. That's why the consistent performance of 'Eclipse' tool bits can be guaranteed.

Cheap tool bits can mean dearer production costs
When you buy tool bits you buy cutting capacity and it pays to buy the best. 'Eclipse' tool bits keep cutting longer than inferior tools — reducing time out for regrinds and increasing production.

Tool bit holders can help with production too
'Eclipse' tool bit holders have been specially developed to get the very best from 'Eclipse' tool bits. They have a patent clamp, adjustable to variation of tool bit size which holds the tool absolutely rigid eliminating any tendency to "chatter."

This is just what we need

'Eclipse' tool bits and tool bit holders are the ideal cutting combination

specify



TOOL BITS

Made by James Neill & Co. (Sheffield) Ltd., and obtainable from all tool distributors.

UT 13

Ask the machine shop to check this



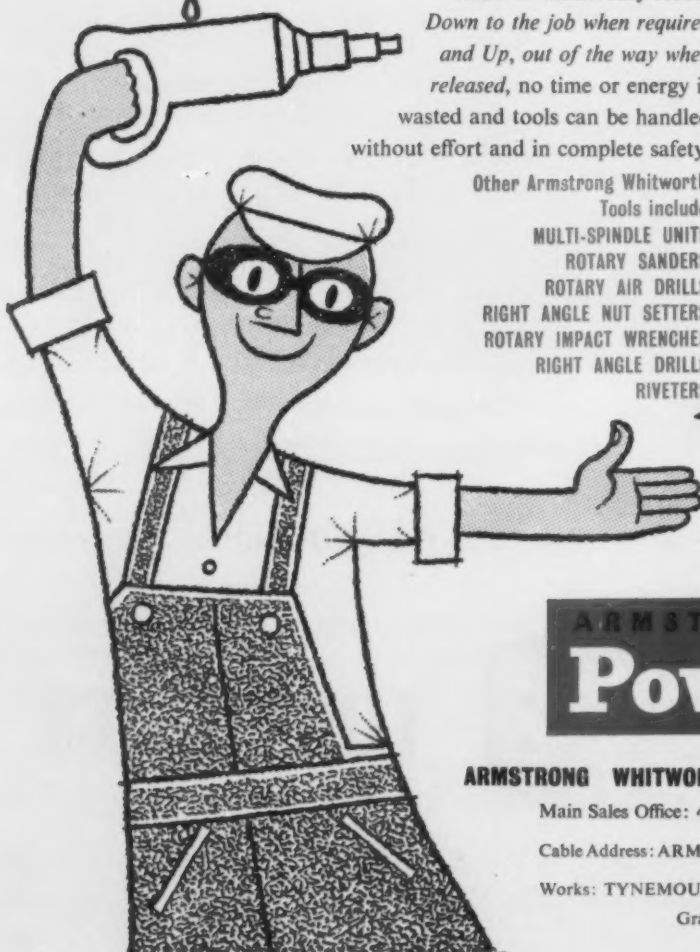
5 lb. Safety Balancer

featherweight balance

ends fatigue!

Armstrong Whitworth Safety Balancers are indispensable where tools must be within easy reach. *Down to the job when required and Up, out of the way when released*, no time or energy is wasted and tools can be handled without effort and in complete safety.

Other Armstrong Whitworth Tools include
MULTI-SPINDLE UNITS
ROTARY SANDERS
ROTARY AIR DRILLS
RIGHT ANGLE NUT SETTERS
ROTARY IMPACT WRENCHES
RIGHT ANGLE DRILLS
RIVETERS



10 lb. Safety Balancer

In addition to the No. 5 and No. 10 illustrated, we have a large range of Safety Balancers. Write today for details—and illustrated literature.

ARMSTRONG WHITWORTH Power Tools

ARMSTRONG WHITWORTH & CO. (PNEUMATIC TOOLS) LTD

Main Sales Office: 40 BROADWAY WESTMINSTER LONDON SW1

Cable Address: ARMWHITTOOL SOWEST LONDON Phone: WHItchall 5944

Works: TYNEMOUTH ENGLAND Phone: NORTH SHIELDS 3111

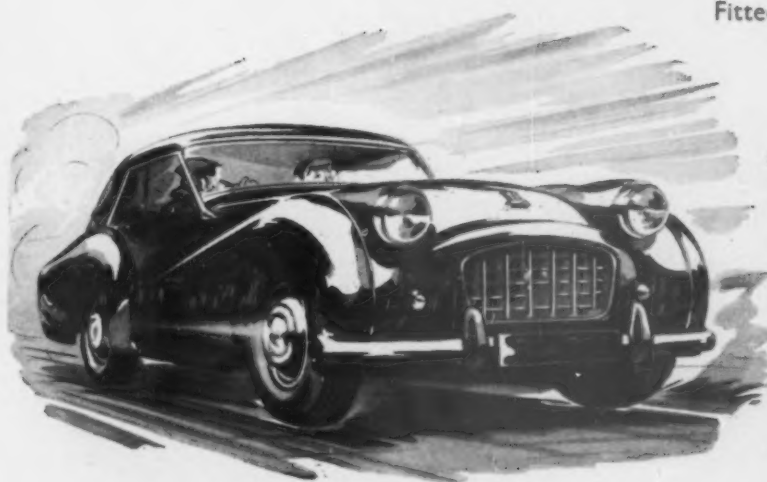
Grams: ARMWHITTOOL TYNEMOUTH R.53

P4174

BEST BRAKES IN THE WORLD

Achievement!

DISC BRAKES FOR PRIVATE CARS



FACTS

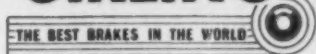
Fitted as Standard Equipment on the famous Triumph T.R.3, Aston Martin DB 2/4 Mk. 3 and Lotus.

GIRLING DISC BRAKES ARE

- ★ Progressive—Consistently safe
- ★ Fade free
- ★ Self Adjusting
- ★ Self Cleaning
Self Drying
- ★ Long Lasting—Wear checked at a glance
- ★ Pad replacement is easy

GIRLING DISC BRAKES

GIRLING



Makers of hydraulically operated DISC BRAKES since 1940

GIRLING LIMITED • KINGS ROAD • TYSELEY • BIRMINGHAM 11



THERMAL FATIGUE RESISTING STEELS

FOR DIE-CASTING, EXTRUSION, STAMPING & FORGING

HOT WORKING TOOL STEELS IN ULTRASONICALLY TESTED FORGINGS...

Our recent developments in this field are the result of careful research by our Technical Staff into the call for increased productivity. Should you wish for details of our specialities please notify us so that we may arrange for one of our Technical Representatives to call upon you.

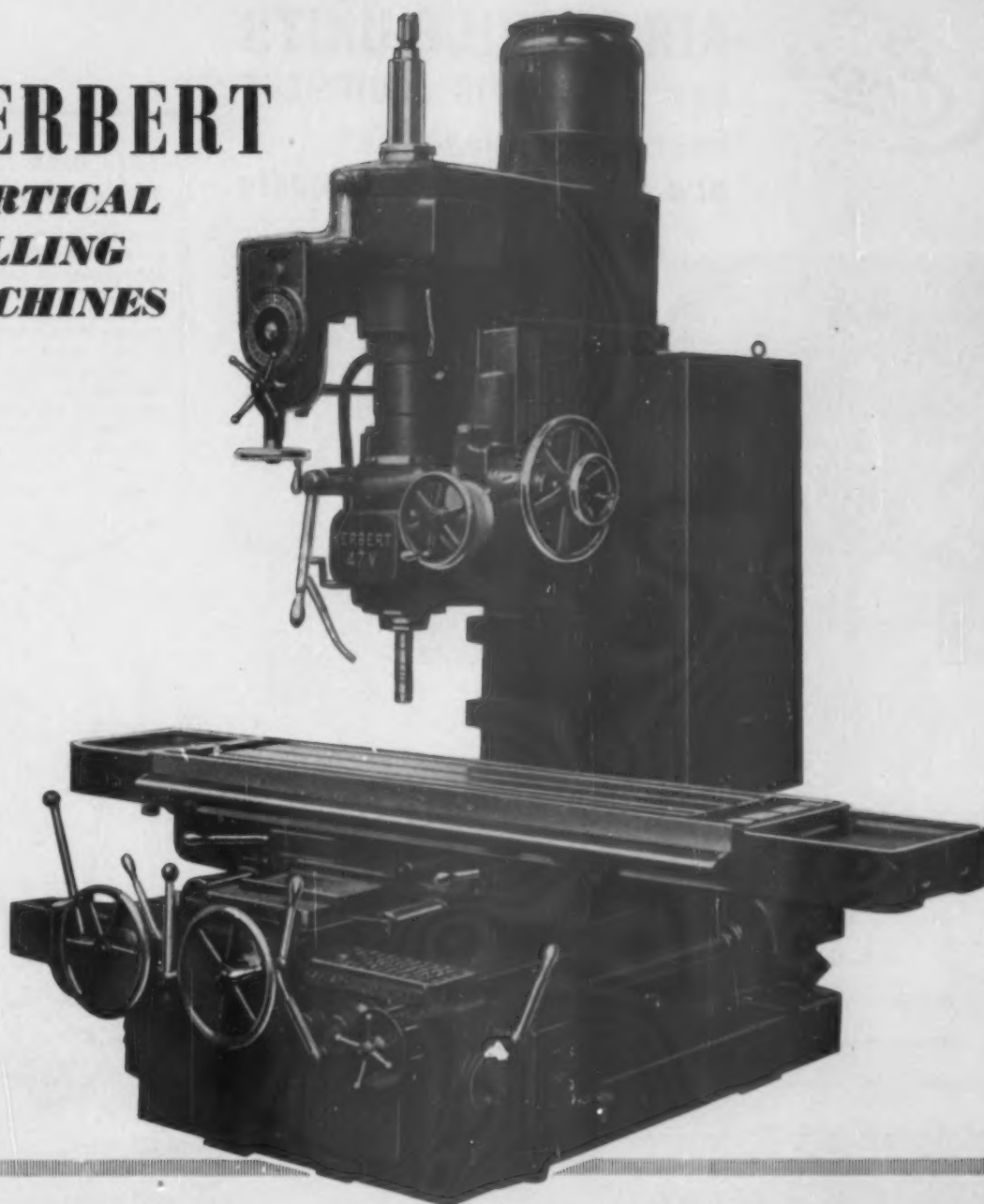


KAYSER ELLISON & CO. LTD.

CARLISLE STEEL WORKS • SHEFFIELD • ESTABLISHED 1825

HERBERT

VERTICAL MILLING MACHINES



ALFRED HERBERT
LTD · COVENTRY

No. 47V. Has the power, speeds, feeds and rigidity for milling materials from aluminium to high-tensile steels. Thirty-two speeds, 21 to 1,525 r.p.m.; twenty-four feeds $\frac{1}{4}$ " to 60" per min.; quick-traverse to longitudinal motion. 48" \times 16" \times 23".

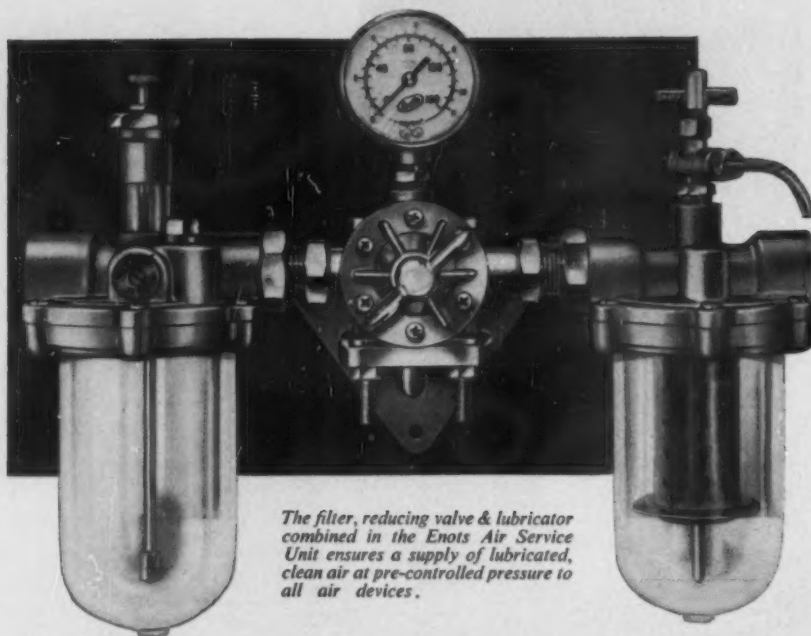
No. 28A. For heaviest class of work. Thirty-two speeds, 12 to 540 r.p.m.; electronic feed drive, infinitely variable feeds between 0.8" and 40" per min.; quick-traverse to longitudinal and transverse motions. 62" \times 29" \times 30 $\frac{1}{2}$ ".

No. 49V. For heavy work requiring large table capacity. Thirty-two speeds, 21 to 1,525 r.p.m.; electronic feed drive, infinitely variable feeds from 0.8" \times 40" per min.; quick traverse to longitudinal and transverse motions. 62" \times 29" \times 28 $\frac{1}{2}$ ".

AD.264





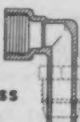



AIR SERVICE UNITS and PNEUMATIC EQUIPMENT *improve efficiency and reduce production costs*



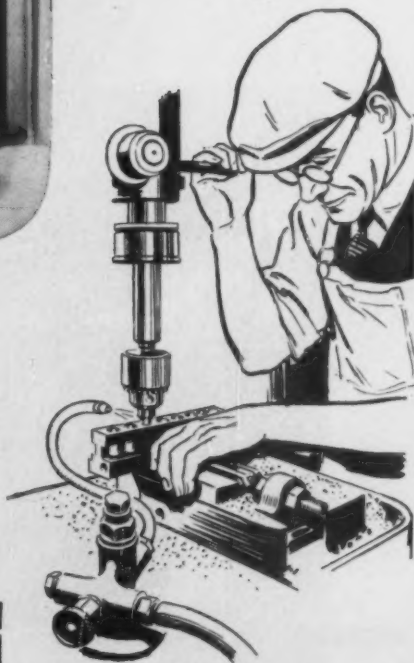
The filter, reducing valve & lubricator combined in the Enots Air Service Unit ensures a supply of lubricated, clean air at pre-controlled pressure to all air devices.

A pressure reducing valve fitted to almost any pneumatic device will save its cost in a very short time by reducing air consumption. At how many points in your works are you using full line pressures of up to 100 lb. per sq. inch where 80, 60 or even lower pressures would be adequate? Savings are more or less in direct proportion to pressure reduction.

 QUICK COUPLINGS	 BLOW HOSE NOZZLE VALVES	 EJECTOR VALVES
 EXHAUST SILENCERS	 SOLDERLESS UNIONS	 COPPER, BUNDY STEEL AND FLEXIBLE TUBES

This man is saving money

He is in fact, saving as much as 90% in compressed air consumption by using an ENOTSPUFFER VALVE in place of an open ended pipe for the displacement of swarf. A leak in a 100 lb. per sq. inch air line, equivalent to a $\frac{1}{8}$ " diameter hole will pass 390 cu. ft. of free air per hour and waste the equivalent of 2 tons of coal per year (2,500 hours operation).



LEAFLET AS357 describing our Air Service Units & individual components and other catalogues on Enots pneumatic devices are available on request.

**BENTON & STONE LTD.,
ASTON BROOK STREET,
BIRMINGHAM, 6 ENGLAND.
Telephone: ASTon Cross 1905**



OAKENSTRONG OAKENCORK

OIL and PETROL
GASKET MATERIALS



SOLE IMPORTERS OF MATERIAL
IN BULK FOR GT. BRITAIN

A. NORDBERG LTD

111, QUEEN VICTORIA ST.,
LONDON E.C.4

TEL: CENTRAL 9678



FOR FOREIGN & COLONIAL
ENQUIRES TO

H. JACKSON LTD

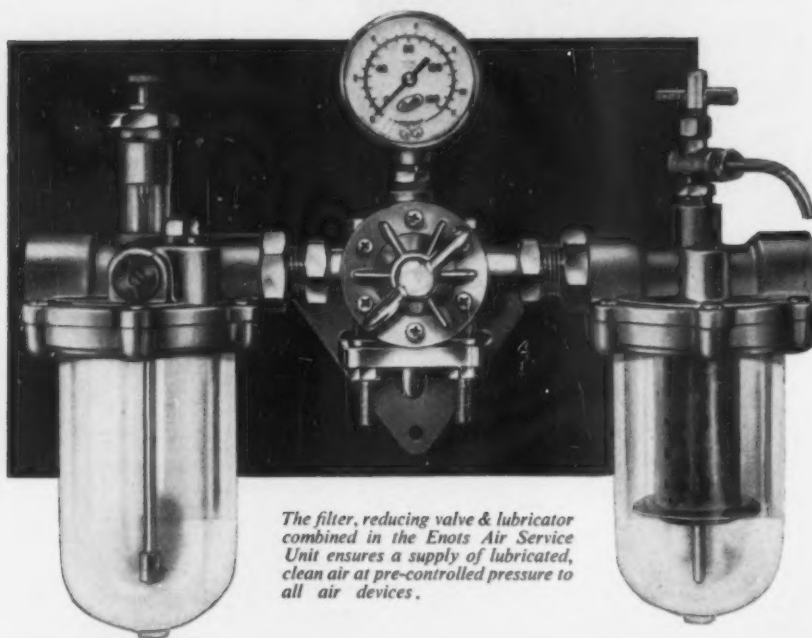
OAKENCLOUGH, GARSTANG,
NE. PRESTON, LANC.

TEL: GARSTANG. 8



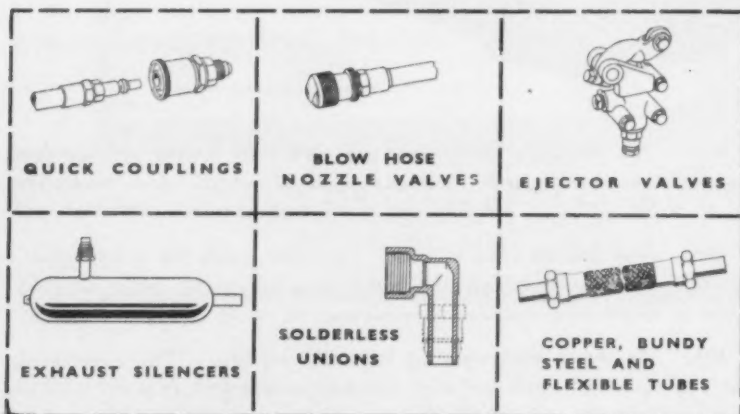


AIR SERVICE UNITS and PNEUMATIC EQUIPMENT *improve efficiency and reduce production costs*



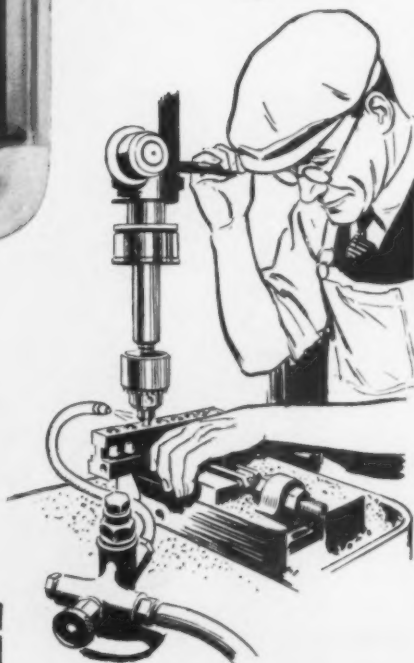
The filter, reducing valve & lubricator combined in the Enots Air Service Unit ensures a supply of lubricated, clean air at pre-controlled pressure to all air devices.

A pressure reducing valve fitted to almost any pneumatic device will save its cost in a very short time by reducing air consumption. At how many points in your works are you using full line pressures of up to 100 lb. per sq. inch where 80, 60 or even lower pressures would be adequate? Savings are more or less in direct proportion to pressure reduction.



This man is saving money

He is in fact, saving as much as 90% in compressed air consumption by using an ENOTSPUFFER VALVE in place of an open ended pipe for the displacement of swarf. A leak in a 100 lb. per sq. inch air line, equivalent to a $\frac{1}{16}$ " diameter hole will pass 390 cu. ft. of free air per hour and waste the equivalent of 2 tons of coal per year (2,500 hours operation).



LEAFLET AS357 describing our Air Service Units & individual components and other catalogues on Enots pneumatic devices are available on request.

BENTON & STONE LTD.,
ASTON BROOK STREET,
BIRMINGHAM, 6 ENGLAND.
Telephone: ASTon Cross 1905



OAKENSTRONG OAKENCORK

OIL and PETROL
GASKET MATERIALS



SOLE IMPORTERS OF MATERIAL
IN BULK FOR GT. BRITAIN

A. NORDBERG LTD

111 QUEEN VICTORIA ST.
LONDON E.C.4

TEL: CENTRAL 9678



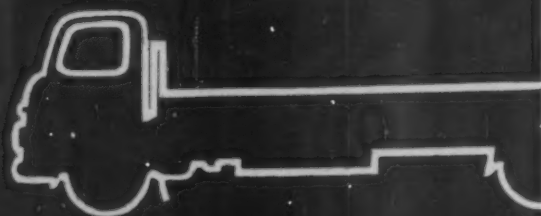
FOREIGN & COLONIAL
ENQUIRES TO

H. JACKSON LTD

OAKENCLOUGH, GARSTANG,
Nr. PRESTON, LANC'S

TEL: GARSTANG, 8





Special Alloy Steels *for* Road Vehicles



FIRTH BROWN

THE FIRTH & JOHN BROWN LIMITED SHEFFIELD ENGLAND

R A D I A T O R S



cool efficiency behind
the hottest styling

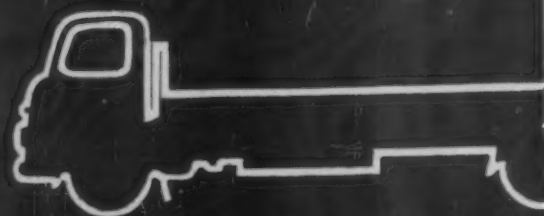
CMF give a design and manufacturing
service, which has been confidently and
confidentially used by automobile engineers
for more than fifty years



COVENTRY MOTOR FITTINGS

COVENTRY ENGLAND Tel. 3144-5-6

Cogent



Special Alloy Steels
for
Road Vehicles



FIRTH BROWN

THOS. FIRTH & JOHN BROWN LIMITED SHEFFIELD ENGLAND

R A D I A T O R S



cool efficiency behind
the hottest styling

CMF give a design and manufacturing
service, which has been confidently and
confidentially used by automobile engineers
for more than fifty years



COVENTRY MOTOR FITTINGS

COVENTRY ENGLAND Tel. 3144-5-6

Cogens

1907

50

1957

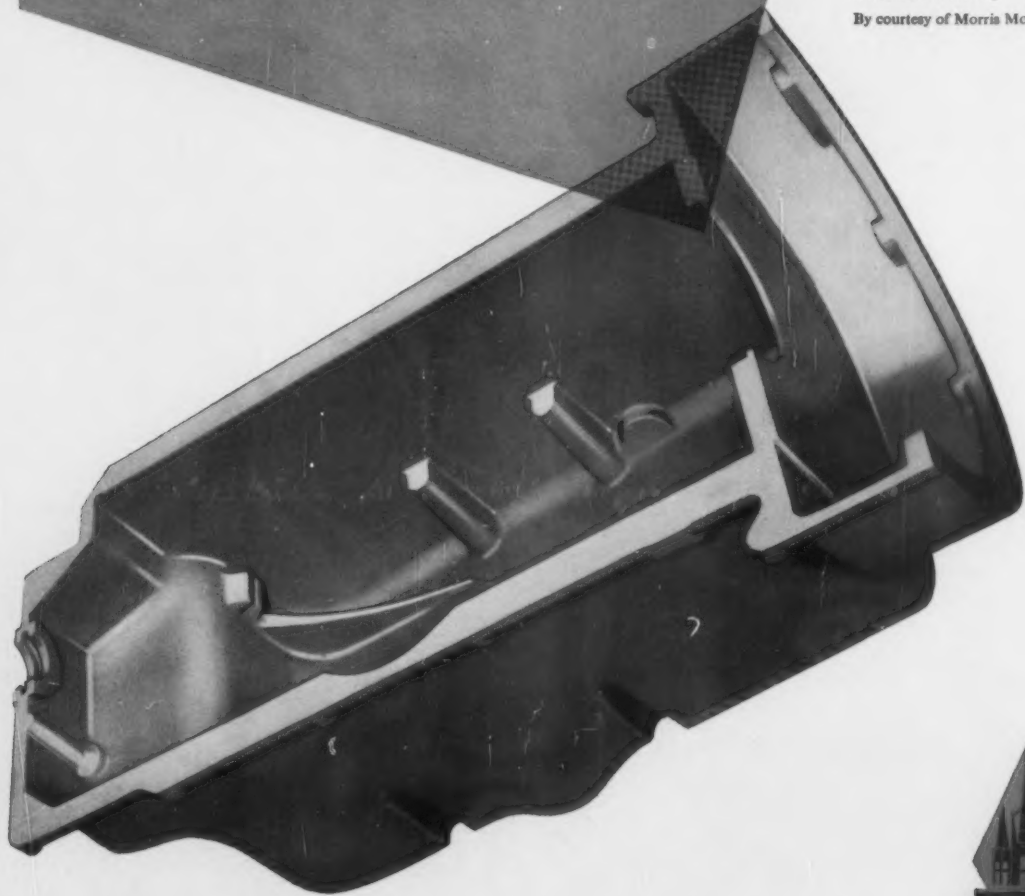
castings by STERMET

This year brings the golden jubilee of Sterling Metals.

For half a century the Company's hallmark has been an unexcelled reputation for skill, quality and craftsmanship. One of the world's largest producers of Elektron magnesium castings, and extensively equipped with iron and aluminium foundries, Sterling Metals will maintain their tradition of service to the aircraft and automobile industries during the years to come.

Castings are made in a comprehensive range of aluminium alloys and the 'Elektron' Magnesium-Zirconium-Thorium series by sand, permanent mould and precision mould methods. Sterling Metals are also specialists in cast iron cylinders and heads.

Permanent mould casting
in Aluminium alloy of
Automobile Oil Sump
By courtesy of Morris Motors Ltd.



STERLING METALS LTD

COVENTRY & NUNEATON



Means to an end

The hands of a craftsman, the skill of years, combining to produce a masterpiece of the cabinetmaker's art. His chisel, like other tools, owes much to correct heat-treatment. That's where Wild-Barfield come in. They pioneered the use of the centrifugal fan, and forced air circulation is still the best available means of tempering, secondary hardening, etc. Correct heat-treatment is only a means to an end but requires properly designed furnaces—and that's what Wild-Barfield have been making for over forty years.

**FORCED AIR
CIRCULATION
FURNACES**



FOR ALL HEAT-TREATMENT PURPOSES

WILD-BARFIELD ELECTRIC FURNACES LIMITED

Elecfurn Works, Otterspool Way, Watford By-Pass, Watford, Herts.

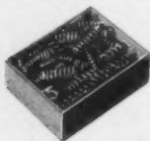
Telephote: Watford 6091 (8 lines)

WB69

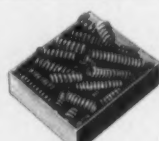
What sorts of springs do you need?



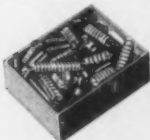
No. 760. 3 doz. Assorted Light Compression Springs. 1" to 4" long, 22 to 18 S.W.G., $\frac{1}{8}$ " to $\frac{1}{4}$ " diam. 6/6 each.



No. 757. Extra Light Compression, 1 gross Assorted, $\frac{1}{8}$ " to $\frac{1}{4}$ ", $\frac{1}{8}$ " to 2" long, 27 to 20 S.W.G. 15/- each.



No. 98A. 3 doz. Assorted 1" to 4" long, $\frac{1}{8}$ " to $\frac{1}{4}$ " diam., 19G to 15G. 5/6 each.



No. 758. Fine Expansion Springs. 1 gross Assorted $\frac{1}{8}$ " to $\frac{1}{4}$ ", $\frac{1}{8}$ " to 2" long, 27 to 20 S.W.G. 15/- each.



No. 388. $\frac{1}{2}$ gross Assorted Small Expansion Springs. $\frac{1}{8}$ " to $1\frac{1}{2}$ ", 18G to 21G. 9/6 each.

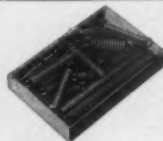
Cut production costs with Terry Wire CIRCLIPS



We can supply from stock in sizes from $\frac{1}{8}$ " to $\frac{1}{2}$ ".



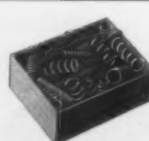
No. 466. $\frac{1}{2}$ gross Assorted Small Expansion Springs $\frac{1}{8}$ " to $1\frac{1}{2}$ " long, $\frac{3}{32}$ " to $\frac{3}{16}$ " diam., 21G to 24G. 6/6 each.



No. 753. 3 doz. Assorted Light Expansion $\frac{1}{8}$ " to $\frac{1}{4}$ " diam., 2" to 6" long, 22 to 18 S.W.G. 10/6 each.



No. 1024. 20 Compression Springs 12" long. $\frac{1}{8}$ " to $\frac{1}{4}$ " diam., 24G to 18G, suitable for cutting into shorter lengths; and 30 Expansions $1\frac{1}{2}$ " to 12" long. $\frac{5}{32}$ " to $\frac{1}{2}$ " diam., 22G to 16G. 24/- each.



No. 1013. 1 gross Small Coil Compression Springs, $\frac{1}{8}$ " to $1\frac{1}{2}$ " long, $\frac{3}{32}$ " to $\frac{7}{16}$ " diam., 24G to 19G. 6/- each.

Compression? Expansion? Long? Short? Light? Heavy? Let Terry's BOXES OF ASSORTED SPRINGS settle the question. Just the job for you experimental people—a simply unlimited assortment from our tremendous range of springs of every variety. The 9 boxes shown here are only a few—but why not let us send you a full list—post free.

TERRY'S ASSORTED SPRINGS

HERBERT TERRY & SONS LIMITED · REDDITCH · WORCS
(Makers of quality Springs, Wireforms and Presswork for over a century)

* Interested in Springs
1967 Edition of
"Spring Design and
Calculations"—
post free 12/6d.

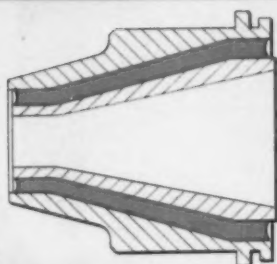
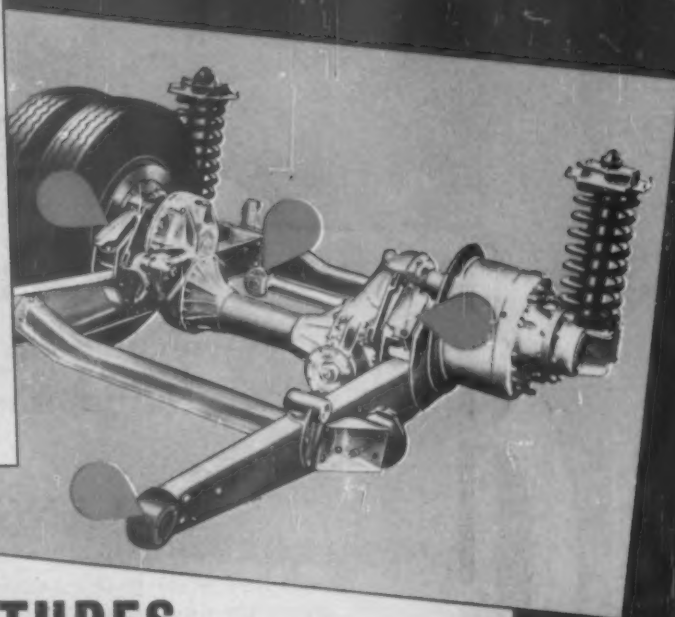
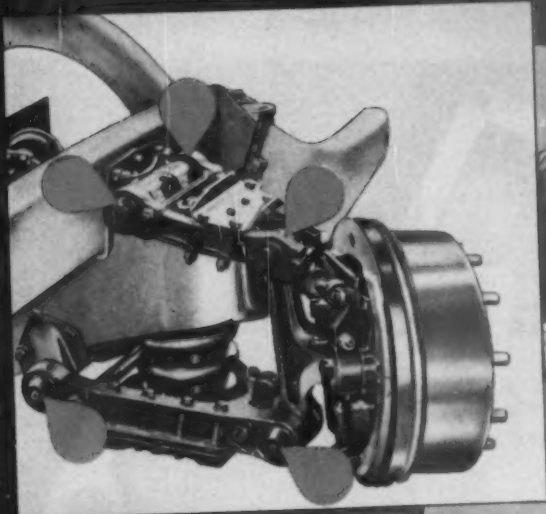


Fig. 1

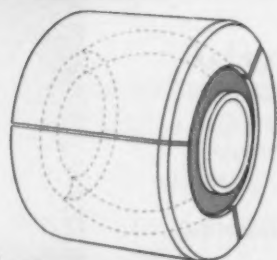


Fig. 2

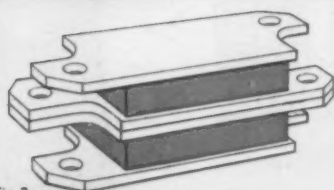


Fig. 3

FEATURES OF INTEREST ON L.T.ROUTEMASTER AND A.C.V. BRIDGEMASTER

These interesting vehicles have independent front suspension with coil springs and wishbones.

The wishbone pivots have Metalastik heavy-duty conical bushes, as shown in the sectional drawing (Fig. 1). These are an important factor in making this type of suspension practicable on a heavy vehicle.

On both vehicles the rear suspension has two substantial trailing arms pivoted to the main suspension members on Spherilastik self-aligning bearings (Fig. 2). The axle assembly is mounted upon the trailing arms by Metalastik sandwich mountings (Fig. 3) at each end. The mountings are arranged in an inverted V formation and permit relative movement of the wheels while increasing roll stiffness and resisting axle wind-up. The transmission of vibration and noise to the structure is reduced by the mountings.


A Panhard rod with a Spherilastik bearing at one end and an Ultra-Duty bush at the other is fitted.

Engine mountings for the Routemaster and the Bridgemaster are supplied by Metalastik.



METALASTIK

METALASTIK LTD., LEICESTER



Widening the choice of
resilient jointing materials

LANGITE

Langite — which for more than thirty years has been used so extensively wherever there is an oil joint to be kept tight — utilizes the natural resilience of cork, bonded together by an original process.

NEOLANGITE

like Langite, embodies cork, but in this case is bonded with appropriate synthetic rubbers.

NeoLangite is used extensively on transformers, aircraft, motor vehicles, etc.; it has a considerable mechanical strength and recovery after compression.

Chingford cork 'jointing' material

For less critical applications, cost may be saved by the use of this material, made alongside Langite but to a less exacting specification. All other types of non-metallic seals, compressed asbestos fibre, impregnated paper etc. can be supplied.

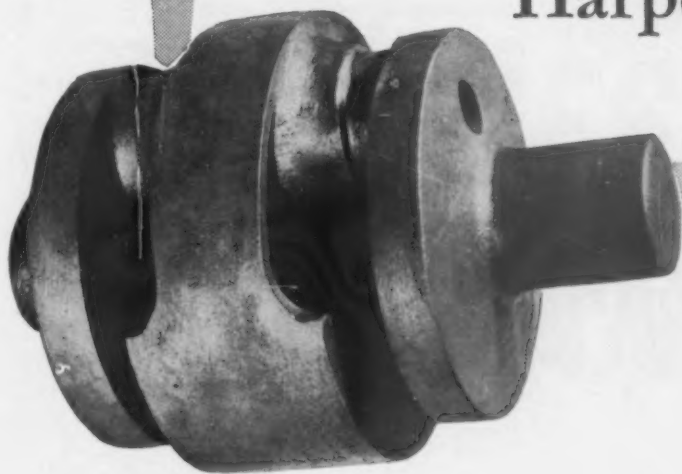
CORK MANUFACTURING CO. LTD., SOUTH CHINGFORD, LONDON E.4
Telephone: Silvershorn 2666 (7 lines)

LANGITE

JOINTING MATERIAL



Quality counts with
Royal Enfield - they use
Harper Castings



The crankshaft for the Royal Enfield 692 c.c. "Super Meteor" Motorcycle, which has to deal with an output of 40 bhp., is machined from a Harper casting—accurate in dimension, free from hard spots and possessing a quality of finish that is unsurpassed.

Harper quality covers grey iron and Meehanite castings, and also metal pressings, machining, enamelling and other finishes and sub-assembly work.



**HARPER
 CASTINGS**



JOHN HARPER & CO. LTD. JOHN HARPER (MEEHANITE) LTD.
ALBION WORKS Phone: WILLENHALL 124 (5 lines) Grams: HARPERS, WILLENHALL **WILLENHALL**

LONDON OFFICE: SEAFORTH PLACE, 57, BUCKINGHAM GATE, LONDON S.W.1 Tel.: TATE GALLERY 0286

MANCHESTER OFFICE: c/o B. J. Brown & Partners Ltd. 248/9 Royal Exchange, Manchester 2

Behind every Compo Bearing



The production of bearings by the powder metallurgy process is our specialized business. Extensive technical research and development are behind every Compo Bearing and enable us to match them to a widening range of mechanical requirements. Powder size analysis, physical testing and extensive running-tests ensure the uniform porosity, structural strength and lubrication capacity of each bearing. The self-lubricating quality of Compo Bronze Bearings overcomes the need for periodic lubrication, making them particularly suited to those less accessible friction points.

POWDIRON SINTERED IRON BEARINGS

Where greater strength is necessary than porous bronze bearings can provide, POWDIRON sintered iron bearings are indicated. There are several specifications, varying in density and strength according to the designed loadings and speeds of journals. POWDIRON bearings are impregnated with approximately 30% volume of oil for self-lubrication.

COMPO OIL RETAINING BEARINGS

products of **BIRFIELD GROUP** experience and resources

MEMBER
OF THE
BIRFIELD GROUP



Bound Brook Bearings Limited

Trent Valley Trading Estate, Lichfield, Staffs

Telephone: Lichfield 2027-8 • Telegrams: Boundless, Lichfield





BRITAIN'S BEST BANDSAWS

part of the range of

SPEEDICUT
*The Hallmark of
Engineers' Cutting.* **TOOLS**

Made in Britain's Largest Engineers' Tool Factory
**FIRTH BROWN TOOLS LTD.,
SHEFFIELD**

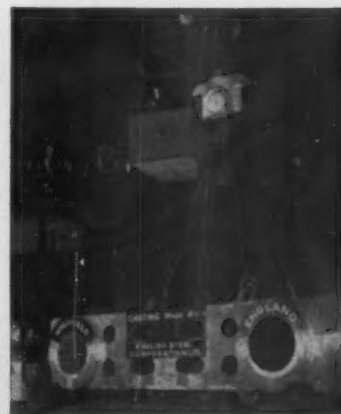
LARGE LOAD



... and the Belleville makes it possible ...!

The largest capacity spring balance in the world. This instrument was made to weigh giant steel castings and is graduated up to 200 tons with 1 ton sub-divisions. It is approved by the Board of Trade for "Trade" purposes, where the requirement is that the machine must be accurate to within a quarter of its smallest sub-division.

Two Belleville washers, in this instance opposed to each other, supply the spring resistant. Their total movement under full load of 200 tons is never more than $\frac{1}{4}$ of an inch.



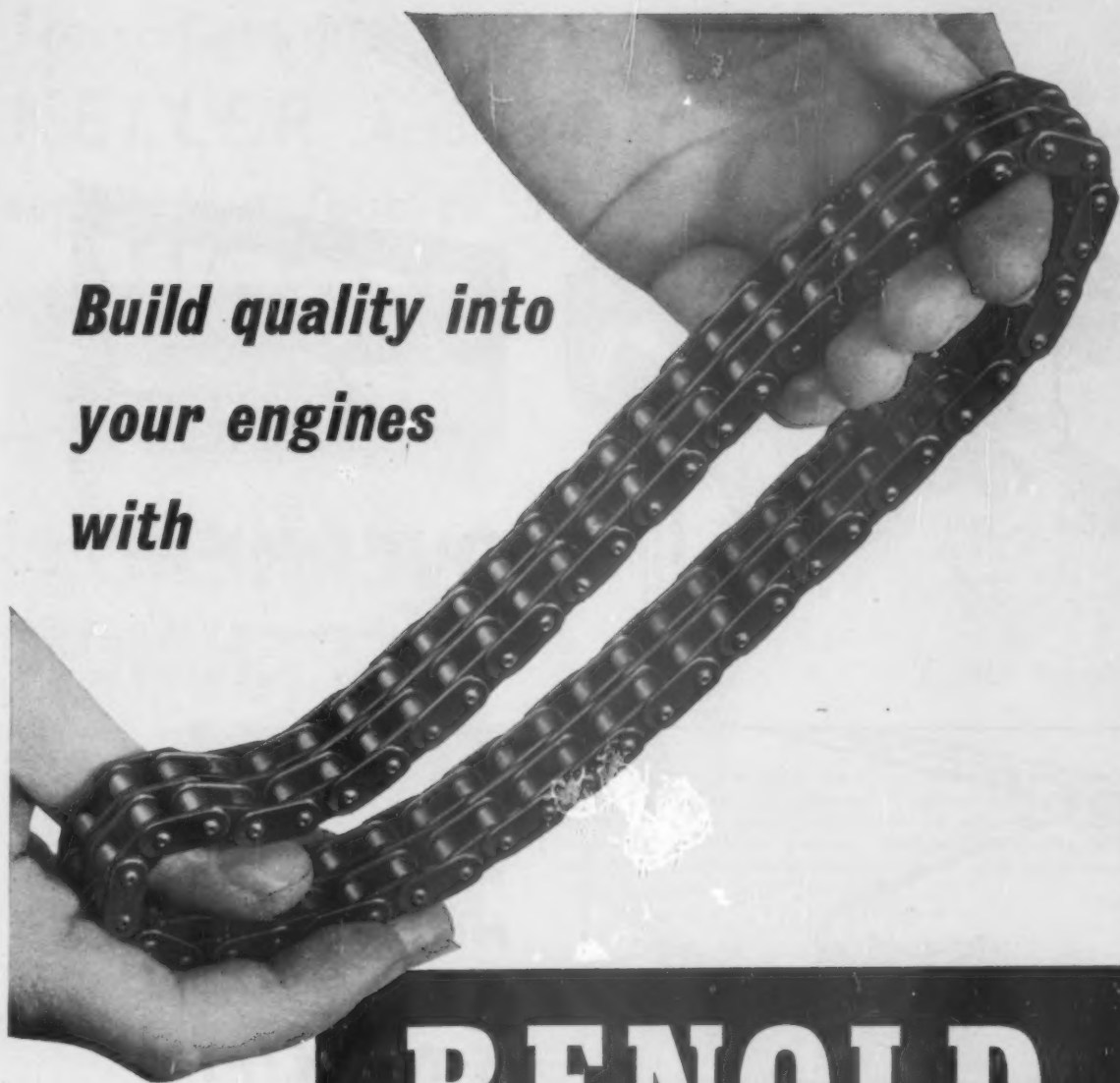
SALTER...
...always a spring ahead!

- ★ When resistance to load or thrust is beyond the capacity of helical springs,
- ★ When take-up of shock or sustained load must be restricted to very slight movement,
- ★ When many tons of dead load must be sustained plus intermittent shock or live load . .

It's time to call in SALTER technicians

GEO. SALTER & CO. LTD., WEST BROMWICH, ENGLAND ESTABLISHED 1760

***Build quality into
your engines
with***



RENOLD

TIMING CHAINS



RENOLD — the FIRST name in precision chain

RENOLD CHAINS LIMITED MANCHESTER



ACROW DEMAG

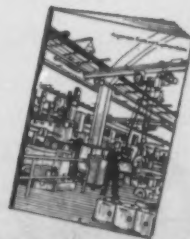
OVERHEAD SUSPENSION TRACKS

with
HOISTS & CRANES
up to
5-TON LIFT

**YEARS
AHEAD
IN
DESIGN**

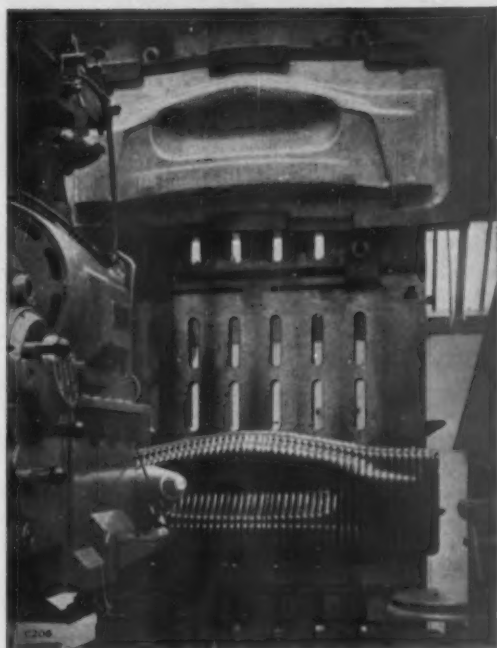
- Can be fixed to almost any type of roof construction.
- All parts standardised for easy assembly and adaptation to local conditions.
- Highest grade materials result in low deadweight and small dimensions.
- Loose suspension eliminates jamming of cranes.
- Curves negotiated down to 4 ft. radius.

For fully illustrated brochure (No. 314) apply to Sole Agents in the U.K. for Demag-Zug :-



ACROW (ENGINEERS) LTD., SOUTH WHARF, LONDON, W.2. AMBassador 3456 (20 lines)

Tracer-Controlled Copy Milling— **KELLER** Automatic Toolroom Machines supplied in Four to Six months



Model-holding plate movable on the work-holding plate. Either plate can be turned without disturbing the model or work. Coolant and swarf flow downwards, leaving cavities clear, thus allowing free cutting and fully automatic working with a minimum of supervision.

KELLER B.G.21 MACHINE

Three types available in a range of sizes:—

Type B.L.

30"×20" Single or triple spindle

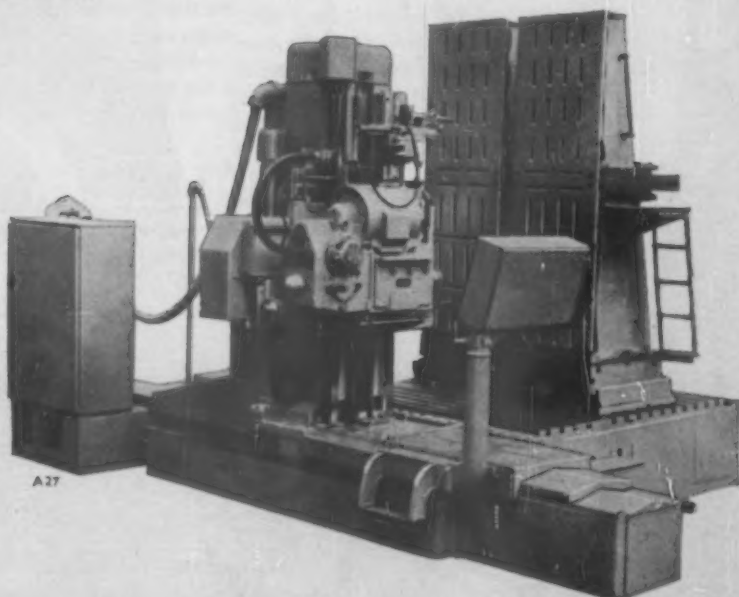
Type B.G.21

5'×2½', 6'×4' and 8'×4' Single or double spindle

Type B.G.22

10'×5', 12'×6' and 14'×7' Single or triple spindle

Cutting action obtained by moving machine elements: work is held stationary. The size and weight of work does not cause deflection and therefore has no effect on cutting accuracy. No fixed distance between work-table and spindle, thereby enabling a wide range of work thicknesses to be accommodated.




A27

AD.168

ALFRED

HERBERT

LTD., COVENTRY — FACTORED DIVISION, RED LANE WORKS



**HEAVY DUTY
TRANSPORT**

MARINE DIESELS

AIRCRAFT

**MINING
MACHINERY**

**EARTH MOVING
EQUIPMENT**

MACHINE TOOLS

**MAXIMUM MARKS TO
SINTERLINK FOR**

Low Rate of Wear • Smooth Operation
Stability • Absence of Fade • High
Thermal Conductivity

Think of the clutch...

think of SINTERLINK

With SINTERLINK lined clutches the user can keep his machines and transport on the go — and his hand out of his pocket. The *designer* of those machines and that transport can use a smaller clutch or less plates. SINTERLINK is as important as that.

Because it is metal, and because of its uniform granular structure, SINTERLINK ensures rapid and effective heat dissipation (no "fade"!) infinitely longer life and greater gripping power under heavy duty conditions. SINTERLINK clutch plates are available in the continuous band type, or in the unique Morgan button pattern for even more rapid heat dissipation.

Any Questions?

... if there are, write for informative printed matter or 'phone for justifiably enthusiastic and knowledgeable technical representative.

**THE FINAL FACTOR
in power transmission**

MORGAN SINTERLINK

THE MORGAN CRUCIBLE COMPANY LIMITED
Battersea Church Road, London, S.W.11 Telephone: BAT 8822

SM/127/A



CLAYFLEX

FLEXIBLE BEARINGS

The continuing improvement in the standard of performance of the modern road vehicle results in ever-increasing demands being made upon the components. The Clayflex Principle is a recognition of the need to provide a flexible bearing which, by design improvement, has the capacity to meet the more arduous conditions imposed upon it by everyday modern motoring. The success of the Clayflex Principle lies in the combination of two familiar techniques, chemical bonding and pressure bonding. The well-known advantages of the pressure bond obtained by controlled rubber deformation upon assembly are reinforced by the addition of chemical bonding of rubber to inner member. It goes without saying that the claim to success could not be made unless the technical improvement involved no additional cost. Clayflex Bearings are competitive.

A fully illustrated brochure is available, and requests for copies are welcomed from Chief Technicians and Buyers.

HOWARD CLAYTON-WRIGHT LTD

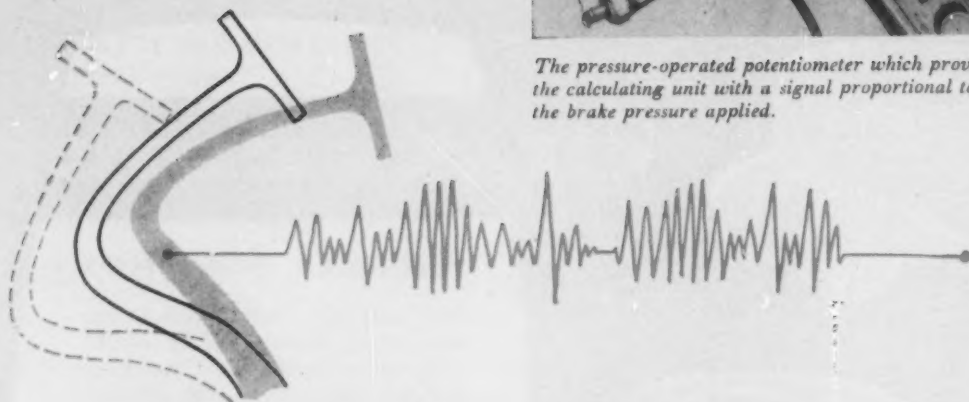
WELLESBOURNE • WARWICKSHIRE • ENGLAND

Phone: Wellesbourne 316/7/8 | Grams: Clatenrite Wellesbourne

BACKGROUND TO BRAKING No. 1



The pressure-operated potentiometer which provides the calculating unit with a signal proportional to the brake pressure applied.



Electronics aid the search for Safety

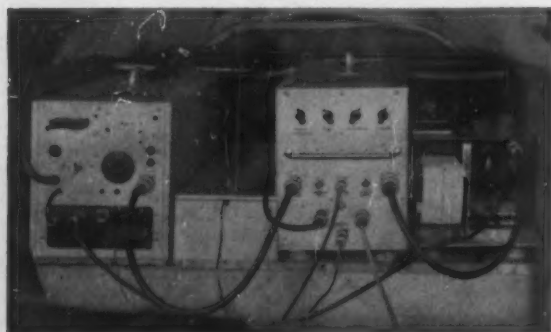
In devising schedules for tests, Ferodo research workers must know what is expected of a brake lining under practical conditions. Without this information it is possible to overrate the lining—make it break down in a manner which would not occur in service.

The performance of a brake lining depends mainly upon the rate at which work is done at the brake and upon the temperature of the drum surface. To record this information Ferodo technicians have installed ingenious apparatus on a vehicle of the Ferodo Test Fleet.

A tachometer generator, driven by the vehicle's propeller shaft provides a signal which is used to record the speed and the deceleration of the

vehicle on a high-speed multi-pen recorder. A voltage proportional to the product of the hydraulic pressure in the brake system and the speed signal is applied to a third pen. Subject to certain necessary precautions, in particular that the brake factor should be frequently checked experimentally, this product is a measurement of the rate of working at the brakes. A thermister is soldered to the surface of the drum to record temperature on a fourth pen.

The results enable Ferodo to devise testing schedules that are accurate and reliable and so to produce brake linings with a high resistance to fade and wear.



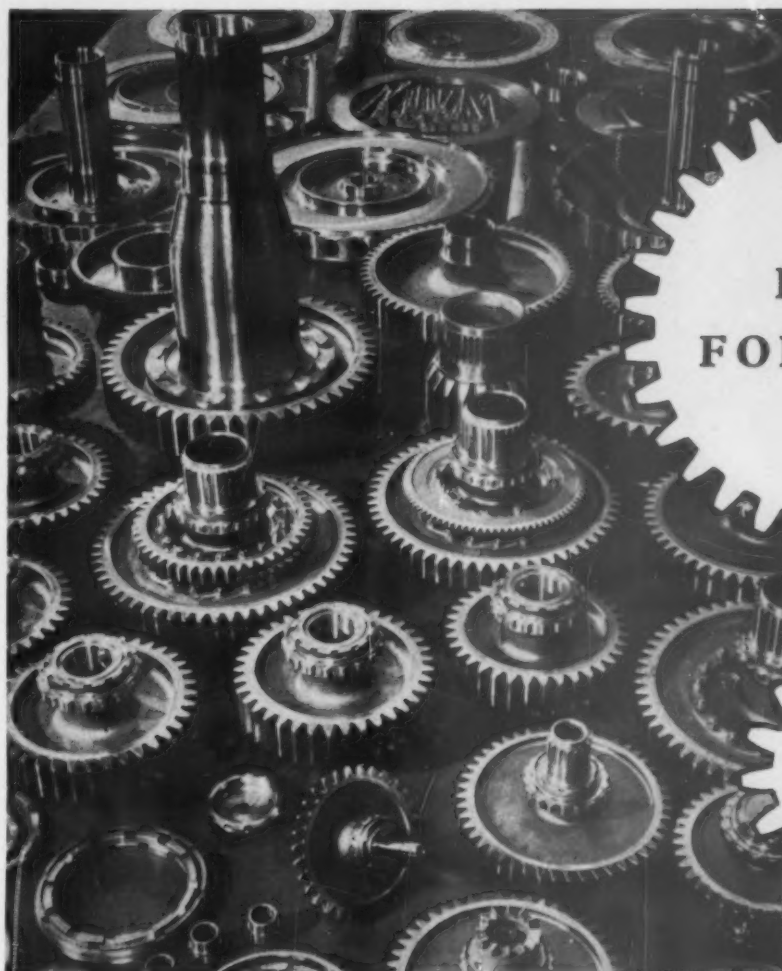
Some of the apparatus in the back of a test car. The power pack is on the left and the chart can be seen emerging from the four pen recorder.

FERODO

ANTI-FADE Brake Linings

FERODO LIMITED · CHAPEL-EN-LE-FRITH

A Member of the Turner & Newall Organisation



**DROP
FORGINGS**

for

every

**Engineering
Industry**

**FIRTH
DERIHON**

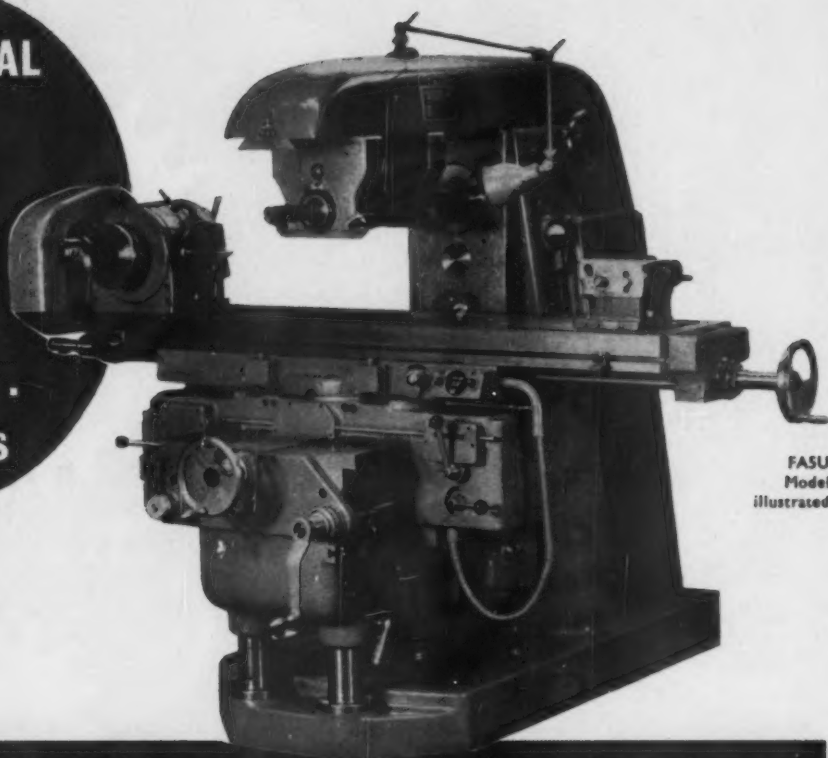
**In
STAINLESS
HEAT and
CREEP-RESISTING
STEELS - AND
ALLOYS**

SHEFFIELD & DARLEY DALE.

THE FIRTH-DERIHON STAMPINGS LIMITED

HORIZONTAL
UNIVERSAL
VERTICAL

**All sizes . . .
. . . all types**



FASU
Model
illustrated

ZBROJOVKA MILLERS

*Early delivery of all
models*

SOLE AGENT



BRIEF SPECIFICATIONS

FOUR SIZES	No. 2	No. 3	No. 4	No. 5
Working surface of table (approx.)	48" x 8"	50" x 18"	64" x 12"	80" x 16"
Power longitudinal travel (approx.)	25"	32"	40"	50"
Power cross travel (approx.)	8"	8"	12"	16"
Spindle Speeds	83-2500	45-3500	22-1400	15-1400

The Selson Machine Tool Co. Ltd

41-45 MINERVA ROAD, NORTH ACTON, LONDON, N.W.10

Telephone: Elgar 4000 (10 lines) Telegrams: Selsomachi, London, N.W.10

THE
600
GROUP

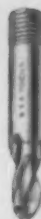


**B.S.A. - ACME
SNAP - LOCK
LIMIT
SWITCHES**

incorporating
proved principles
of design and
construction.
STANDARD type,
water, oil and dust
proof and the
NEW FLAMEPROOF
version for opera-
tion where
Groups I, II or III
gases may be
encountered.



**BROACHES,
MILLING CUTTERS,
SCREWED SHANK TOOLS AND
CHUCKS,
TWIST DRILLS, DRILL HOLDERS
AND SETTING GAUGES,
CENTRE DRILLS, REAMERS,
CUT THREAD AND GROUND THREAD TAPS,
TAP WRENCHES, TAPPING ATTACHMENTS,
SCREWING DIES, DIE STOCKS,
DISHEADS, SCREWING SETS,
DRILL CHUCKS, LATHE CHUCKS,
MACHINE VICES, MILLING
MACHINE ARBORS,
OIL AND SUDS
PUMPS**



B.S.A. TOOLS LIMITED

ENGINEERING DIVISION

100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000



PHILIDAS

Self-locking Nuts

NEVER LOSE THEIR GRIP



*FORD—with the new Thames
light commercial vehicle—*



Continue to rely on **PHILIDAS**

These one piece nuts are of all-metal construction—with *no insert*. They stay secure under extremes of temperature and against all vibration—and can be used time and time again.

Most types and sizes available from stock.



Send for our new catalogue

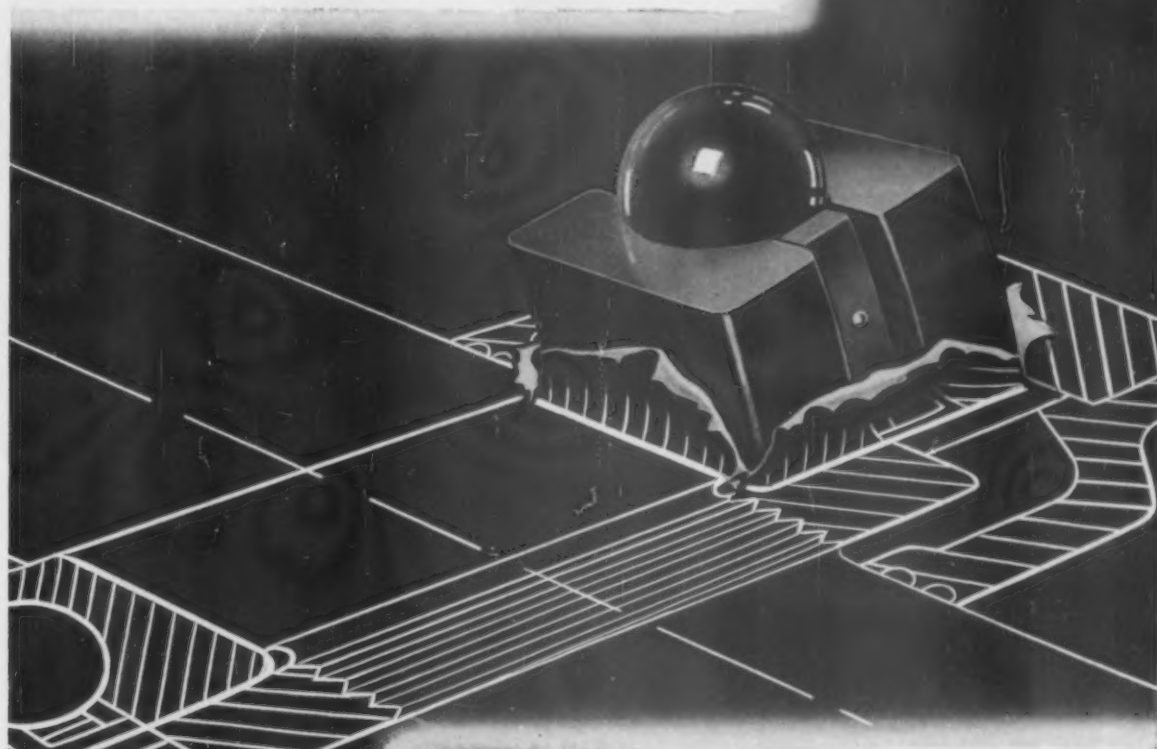
PHILIDAS DIVISION — WHITEHOUSE INDUSTRIES LTD.

FERRYBRIDGE, KNOTTINGLEY, YORKS.
Tel. Knottingley 2323 (5 lines). Telex 55-166.

THEY YIELD ONLY TO A SPANNER

LONDON OFFICE: 44 HERTFORD STREET, W.I.
Tel. Legation 3888. Telex 23549.

In the Blue Print Stage



That's where we come in



BALL & ROLLER BEARINGS

Better let us collaborate with you now and ensure complete success.

Our team of technical experts has over 50 years accumulated experience behind it.

This service is freely at your disposal and entails no obligation



THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX

What happens inside?

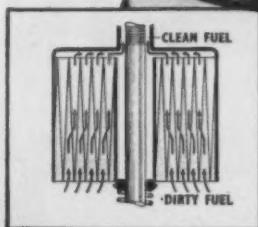
If you cut open the container of a used C.A.V. type 'F' fuel filter, remove the paper element and slice it through, you will see the sludge and dirt which has been prevented from reaching the high precision components of the fuel injection equipment.

The element is of spiral vee-form construction, the paper being creped to provide continuous space between adjacent turns. Dirty fuel is confined to the underside of the paper coil, and filtered fuel to the upper side. The filtering surface is 560 square inches—much greater than that of other types of comparable size, so that a large volume of fuel can be filtered without choking.

The paper used has been most carefully selected and is specially manufactured for the job. It is resin-treated, and of high strength when wet. Paper elements have been subjected to boiling, low temperature, severe vibration and pressure tests, without harmful effect. Most important of all, the paper effectively removes from fuel oil particles of a size which would cause most damage and wear to pump barrels and plungers.

In laboratory tests the new filter gave over six times the life of pump elements obtained with a cloth filter.

C.A.V.
type 'F'
fuel oil
filter



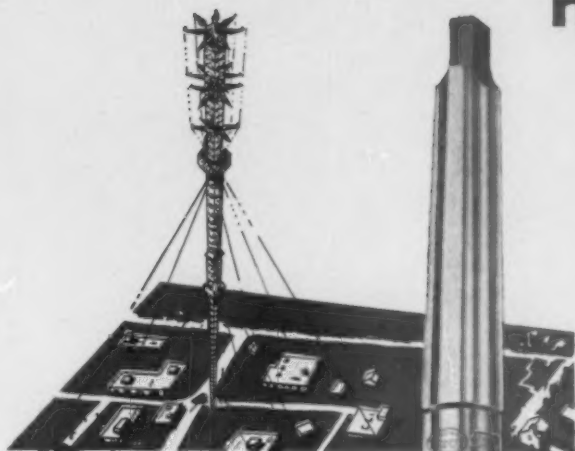
The World's Leading Manufacturers of

FUEL INJECTION EQUIPMENT

C.A.V. LIMITED, ACTON, LONDON, W.3

AP859

An outstanding new feature



The best of two worlds is combined in 'TRUSHANK'—the latest refinement to the famous range of 'Mushet' brand high-speed steel twist drills. The precision ground taper shank ensures an accurate fit in the socket, whilst the body of the drill retains all the advantages of steam temper, with its distinctive blue-black oxide coating.

Order 'TRUSHANK' now and prove their greater efficiency during a longer and trouble-free life. They cost no more.

'DOUBLE MUSHET'
HIGH SPEED STEEL



BRIGHT SHANK

Precision ground for accurate drilling.

STEAM TEMPER

Stress free, reduces friction and resists corrosion.

'TRUSHANK'

OSBORN

TWIST DRILLS

SAMUEL OSBORN & CO., LIMITED
CLYDE STEEL WORKS, SHEFFIELD



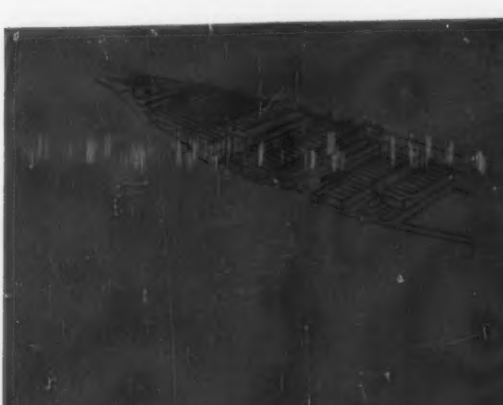
MAN MAKES PROGRESS

It is progress as a man could be to ride, and how the penny farthing showed many a nation's heart. Very easy to work, though, and you'd soon adjust his eyes and ears. The key word is a bicycle's frame, steel adds strength which makes steel makes a lasting career, in sports and town. In the days of the "Penny Farthing", Lee of Sheffield has already leading a world for the supply of wire and steel to the cycle industry, the basis of a partnership that has increased with the years. Leading cycle manufacturers of to-day use Lee's Steel.



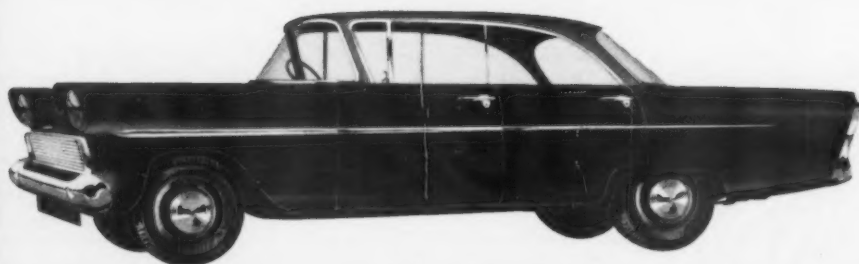
LEE of SHEFFIELD

BRIGHT BARS, COLD ROLLED STRIP AND FLATTENED WIRE, HIGH STRAIN STEEL WIRES, "TRUBRITE" STAINLESS STEEL STRIP AND WIRE.



PROGRESS MAKES MAN

Another thrilling element on the road, the Lee of Sheffield quality of steel polished steel. Used more and more by the great motor car for its industry, Lee's Steel leads the assembly line for big cars and engines... and the finished product is highlighted by "Trubrite" Stainless Steel. Lee of Sheffield to-day, and tomorrow will continue to play an increasing part in making Britain's industries.



Head Office and Works: Trubrite Steel Works, Messing Hall, Sheffield, 10, Sheffield Street, Leeds. Also at: Crown Works, Glasgow, Dundee, and London. Agents: Messrs. J. & J. Morgan, 10, Abchurch Lane, London, E.C. 4. Telephone: 01-4041111.

vehicle springs

to
your
specification



also
UPSET
FORGINGS

KANTLINK
SPRING WASHERS

Will not link together into
chains; in all sizes A.S.A.
or S.A.E. medium type.

TOLEDO WOODHEAD SPRINGS LIMITED · SHEFFIELD 3

COLES

THE NAME THAT
CARRIES WEIGHT



MODEL S1210C
AENEAS



Driver's...
Limit Switches—Automatic...
Radius Indicator—Showing maximum loads at various radii...
Equipment—Electric starter, electric horn and instrument panel. Toolbox with complete tool kit is provided.
Jib—Cantilever lattice construction. Standard length 30' 0". Optional length 30' 0".
Speeds—
HOISTING on Single Line
Load, tons — 2 1/2 2 1 1/2 1
Speed, f.p.m. — 60 90 120 150
DERRICKING—Maximum to minimum radius in 30 seconds.
SLEWING—3 c.p.m. with load.
TRAVELLING—3 1/2 m.p.h. unloaded and 2 m.p.h. loaded on firm level ground.
Trotting Radius—20 ft.
Ground Clearance—10 in.
Weight—With jib 40,000 lb.

WEDNESDAY

C.F.E. The big hands in
our industry buy
these Peoples cranes
— Find out why! R.T. 1

Designed, Manufactured and marketed by
STEELE ENGINEERING PRODUCTS LIMITED
Luton Road, Luton, Beds. LU1 3JH (17 Miles S.W. of London)
Luton Works: Luton, Beds. LU1 3JH (17 Miles S.W. of London)
Luton Works: Luton, Beds. LU1 3JH (17 Miles S.W. of London)



An entirely new form of tipper construction in Timinium alloys giving a very light body of immense strength.

This body is one of the Standard Bonallack range.

payloads go UP

Higher payloads, lower maintenance costs — that's what *Timinium* offers to the commercial vehicle operator. Its lightness can cut down bodyweight by as much as 50% and may well mean a lower rate of tax: its freedom from rust and its high resistance to corrosion make protective painting unnecessary, and maintenance a formality. Our Development Department is ready to co-operate on any application of *Timinium* in vehicle building.

...when you build in
TIMINIUM

REYNOLDS T I ALUMINIUM LTD. ONE OF THE LARGEST U.K. MANUFACTURERS OF SHEET, CORRUGATED SHEET, STRIP, CIRCLES, PLATE, EXTRUDED SECTIONS AND TUBES — IN THE *Timinium* RANGE OF ALUMINIUM AND ALUMINIUM ALLOYS.

Head Office: Redfern Road, Tyseley, Birmingham 11. Telephone: Acocks Green 4211.

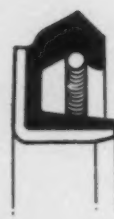
Offices in: LONDON · BIRMINGHAM · MANCHESTER · LEEDS · GLASGOW · BRISTOL · BELFAST · DUBLIN

**TYPE 11 P**

The standard rotary shaft seal. Gives perfect sealing at high speeds and for long periods, with minimum frictional loss.

**TYPE 11 P/B**

As type 11 P but with the casing covered with rubber. Interchangeable with metal case seals.

**TYPE 23 P**

An external seal used when fitting conditions prevent the use of 11 P or 11 P/B seals.

**TYPE 12 P**

A rotary shaft seal used to separate two different fluids.

**TYPE 13 P**

Similar to type 12 P but without a spring on the second lip which serves as a dust excluder.

**TYPE 31 P**

A springless seal used as a wiper or dust excluder for rotating or reciprocating shafts.

**NU-LIP RINGS**

A special section ring which cannot twist. Superior to the O-ring for low and medium pressure non-static applications.

**O-RINGS**

A compact automatic seal for reciprocating and static applications over a wide range of temperatures and pressures. All British Standard sizes in stock.

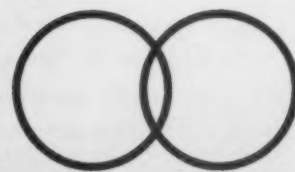
**TYPE 7 P**

A hydraulic and pneumatic seal used chiefly on reciprocating pistons or as a valve stem packing. Normally fitted in a groove.

PIONEER OILSEALS O-RINGS AND HYDRAULIC PACKINGS

Every fluid sealing application comes within the Pioneer range. Write NOW for the PIONEER OILSEAL LITERATURE.

The PIONEER man is trained to solve your sealing problems on the spot. Call him in now.



PIONEER OILSEALING & MOULDING CO. LTD.

A DIVISION OF J. H. FENNER & CO. LTD

Factory and Head Office: Cottontree Works, Colne, Lancs. Tel. Wycoller 471 (8 lines).

FUNDITOR

ALL PURPOSE

★ *Electric Ovens*

for

DRYING, CURING,
BAKING, SOFTENING,
TEMPERING, BONDING,
PRE-HEATING, AGEING,
DE-EMBRITTLING, Etc.



FUNDITOR electric ovens have won a reputation throughout industry for their ability to meet varied requirements economically and efficiently. The range of models covers types from small bench equipments up to large batch ovens.

FUNDITOR ovens are supplied with either forced air circulation, or as natural convection ovens with temperature ranges up to 350°C. and 450°C. respectively.

Rapid and uniform heat distribution combined with precise automatic temperature control, are basic features of FUNDITOR design. Double-skin construction with fibre-glass lagging ensure minimum heat loss by conduction through steel casting.

FUNDITOR ovens can be equipped with process timers, automatic time switches, temperature recorders, programme controllers where necessity demands.

Although our range of standard ovens is very wide, we are always pleased to supply 'specials' to meet requirements.

Write for further
particulars.

FUNDITOR LIMITED

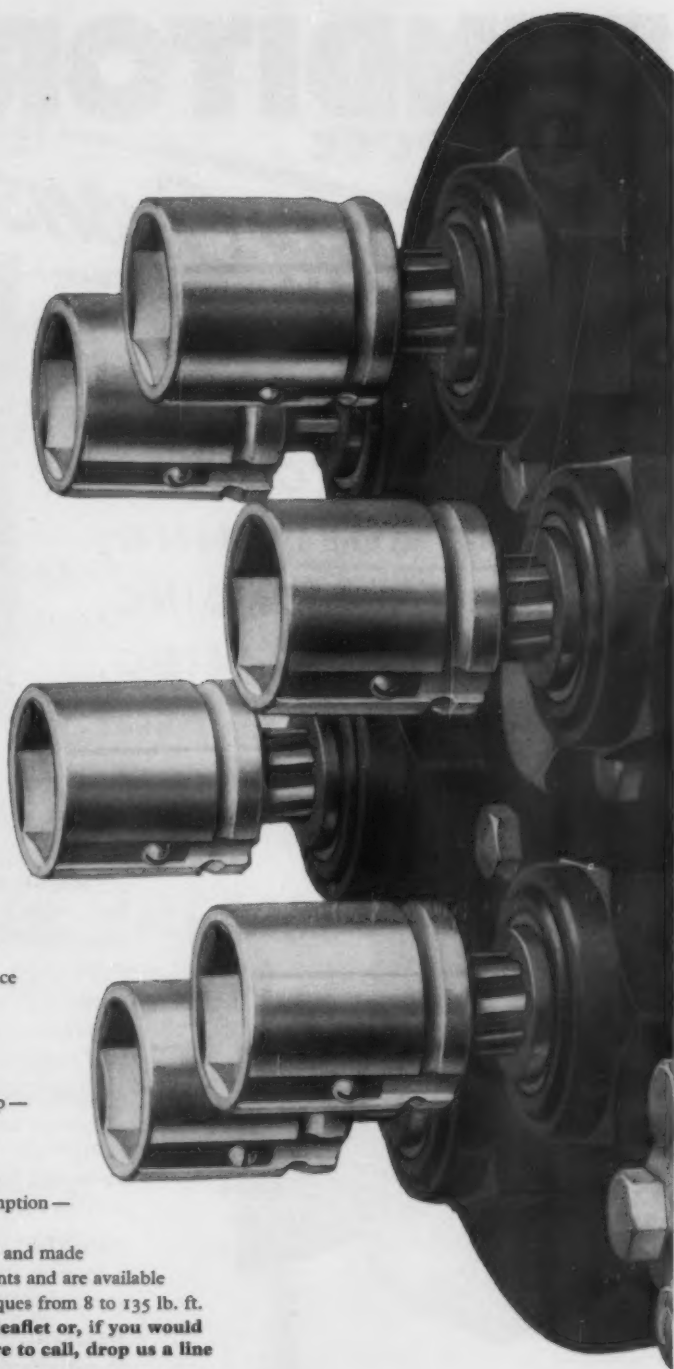
WOODBIDGE HOUSE • 3 WOODBRIDGE STREET
LONDON, E.C.1

TELEPHONE: CLERKENWELL 6155-57

CABLE ADDRESS: FUNDITORS, CENT, LONDON

Silent
new **MULTIPLE**
nut runner units
produce torques of

135 lb.ft.



For years we've been making pneumatic multiple nut runner units with motors producing torques of up to 50 lb. ft. The new Desoutter motors produce torques of up to 135 lb. ft.—without consuming any extra air.

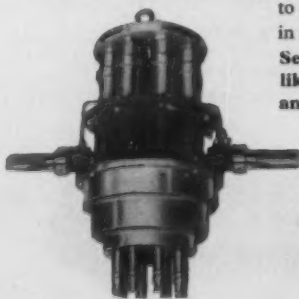
What's the big secret? A motor with a 2-speed gearbox. This motor works at fast speeds for running down nuts, at slow speeds for tightening up—and the change of speed is automatic.

Compared with any other multiple units these new Desoutter tools give *three* times the performance—or the same performance at one third the air consumption—with even greater uniformity of torque.

Desoutter Multiple Nut Runner Units are designed and made

to individual requirements and are available in a wide range, for torques from 8 to 135 lb. ft.

Send for descriptive leaflet or, if you would like our representative to call, drop us a line and we'll arrange it.



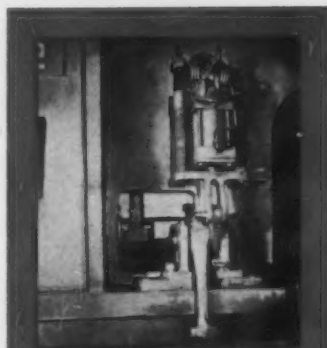
8 spindle unit for
differential housing assembly
(Vauxhall Motors Ltd.)

Desoutter 2-speed multiple nut runner units

DESOUTTER BROS LIMITED, THE HYDE, LONDON, N.W.9. TEL: COLINDALE 6346 (5 LINES). GRAMS: DESPNUCO, HYDE, LONDON
CRC3944

now short run production
is economical with . . .

New Quick Die Change Presses



Dies are changed in press side quickly, conveniently. Shortening adjustment of slide is done in 102 inch.



Each press has two power-driven die carriers that move in and out of press area through vertical openings at back of each bolster.



**PRESSES SHOWN
ENABLE LEADING
EUROPEAN AUTO
MAKER TO MEET
PRODUCTION
SCHEDULES WITH
FEWER PRESSES...
SAVES PLANT &
STORAGE SPACE,
TOO.**



Danly Quick Die Change Presses have TWO bolsters mounted on power-driven carriers which move into or out of the press through large openings in press sides. This new principle permits the press to continue in full production while another die is set up on a bolster outside. Die change is reduced to a matter of minutes. Ease and rapidity of die change makes controlled production in short runs virtually as economical as long runs. A leading European auto maker uses two complete lines of these presses because they also offer other important advantages:

STAMPING PRODUCTION INCREASED OVER 40%. Production time is increased because die change time is reduced. A die can be removed for normal maintenance—and another snatched into place—with

practically no interruption in production.

DIES CHANGED IN 5 MINUTES. A die may be set up in advance on a bolster outside the press. Complete changeover—for one press or an entire line—takes just 5 minutes. Mechanical handling devices between presses remain in place during die change.

FLOOR SPACE SAVED. Presses may be set closer together because dies are changed through press sides. Controlled production also substantially reduces the size of storage banks maintained for assembly lines.

DIE TRYOUT IS FAST AND CONVENIENT. Dies may be tried out in the presses that will actually produce the stampings—under supervision of regular production personnel. Time and money are saved.

See how you can benefit from new Quick Die Change Presses.
Bulletin P 43.1 has the facts. Write for it today.



DANLY MACHINE SPECIALTIES, INC.

Represented in England by ——— **GASTON E. MARBAIX LIMITED**
DEVONSHIRE HOUSE, VICARAGE CRESCENT, LONDON, S.W.11., ENGLAND



We're proud of our castings *are you?*

We invite criticism of our castings as we believe that they are as perfect in specification and dimension as modern machinery and metallurgical control can supply them.

If your castings are not up to YOUR standard, perhaps we can help?

Precision grey iron castings, aluminium alloy sand castings, aluminium alloy gravity die and pressure die castings, zinc-based alloy pressure die castings.

West Yorkshire

SAYNER LANE, LEEDS 10

Telephone: LEEDS 29466



Foundries Ltd.

London Office

HANOVER HOUSE, HANOVER SQ. W.1.

Telephone: MAYfair 8561



★ **CONSISTENCY ... FIRST TO LAST!**

DORMER

WE insist that the steels used in the manufacture of **DORMER** tools conform to our own stringent standards.

A team of metallurgical technicians sample, examine and test all steel, and any material falling short of our specifications is rejected.

This emphasis on **CONSISTENCY**, even before manufacture, lays the foundation for your confidence in **DORMER TOOLS**.

Background is a section of steel micro-structure.

**THE
SHEFFIELD TWIST DRILL
& STEEL COMPANY LIMITED
SHEFFIELD · ENGLAND**

**DORMER TOOLS ARE OBTAINABLE
FROM YOUR USUAL ENGINEERS'
MERCHANTS**

all lined up and with **CAPASCO** moulded brake

Regd.

fitted as standard equipment by

A.C.V. LIMITED • ALBION MOTORS LTD

THE AUSTIN MOTOR CO. LTD

BRISTOL COMMERCIAL VEHICLES LTD



THE CAPE ASBESTOS COMPANY LIMITED

and at MANCHESTER: National Buildings, St. Mary's Parsonage, Manchester 3, Tel: Deansgate 6016-7-8; GLASGOW: 217 Bothwell Street, Glasgow C.2, Tel: Central 2175
NEWCASTLE: 19-20, Exchange Buildings, Newcastle Tel: Newcastle 20488

ready to

STOP

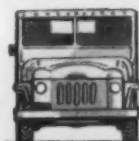
linings

COMMER CARS LTD • FODENS LTD

LEYLAND MOTORS LTD • LONDON TRANSPORT

SCAMMELL LORRIES LTD

TRANSPORT VEHICLES (DAIMLER) LTD



CHAMP



RELIANCE



SUPERPOISE



CLAYMORE



P.S.U.C.I

114 & 116 PARK STREET

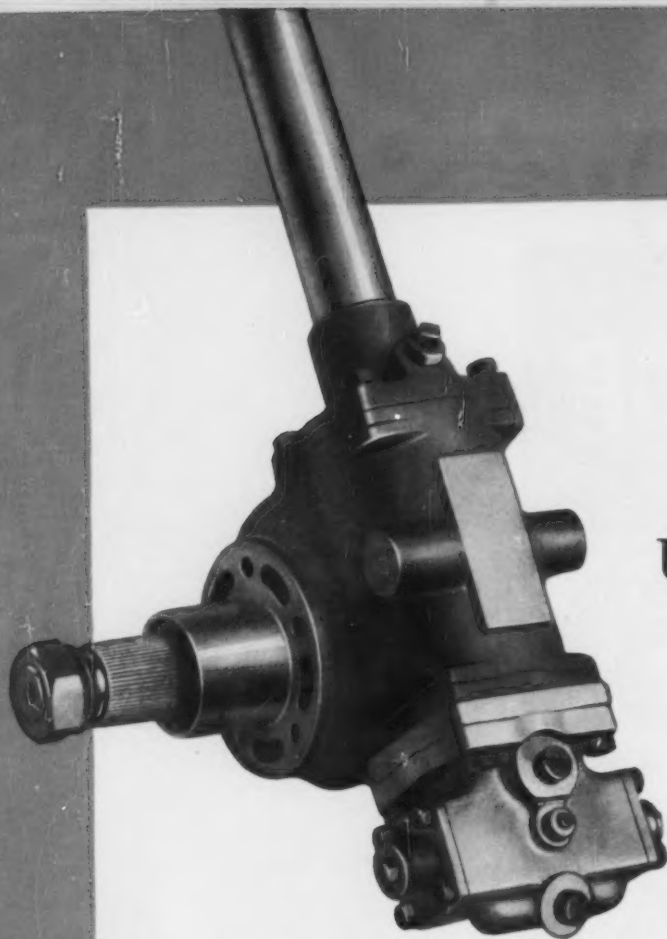
BIRMINGHAM: 11 Waterloo Street, Birmingham 2. Tel: Midland 6565-6-7

LONDON W.1

Telephone: GROsvenor 6022



TA 9472



THE UNIVERSAL UNIT

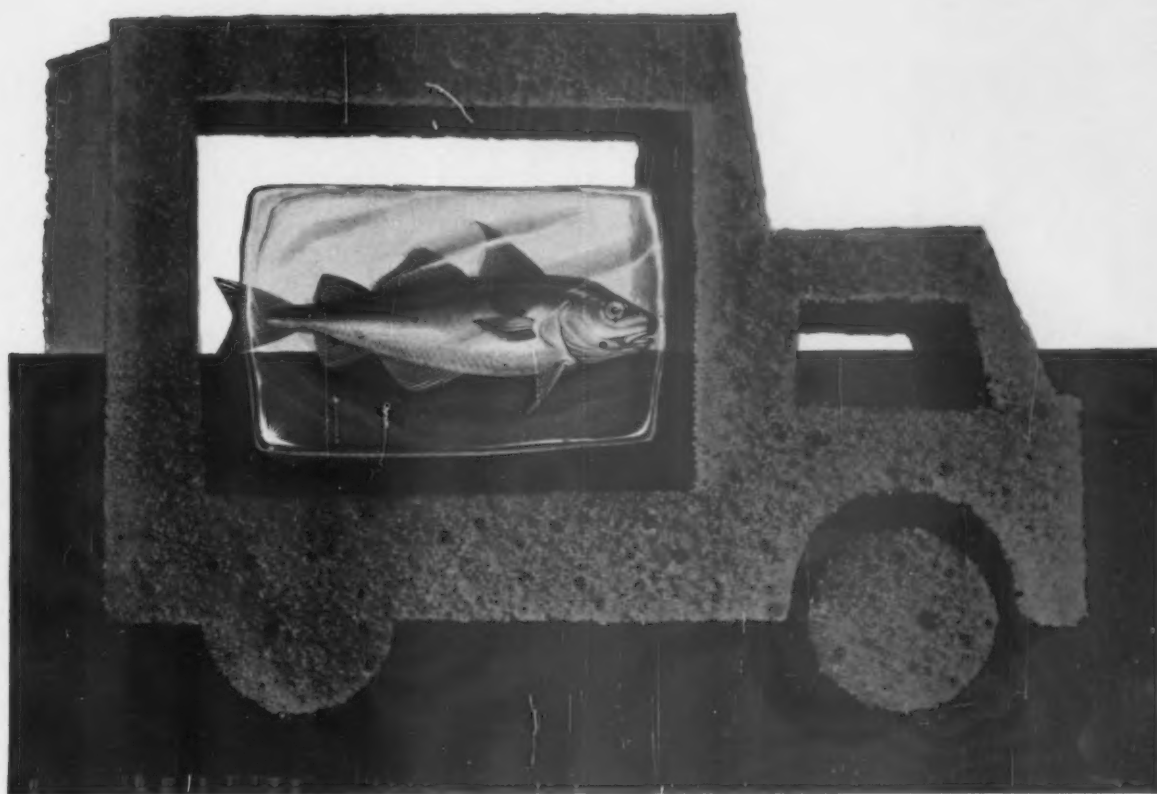
Illustrated above is the Type 3 'Universal' steering gear which incorporates the hydraulic control valves mounted upon our type '861' manual gear. This is for use with a separate power pump and with power cylinders operating on the steering linkage. Further particulars will be sent on request.

ADAMANT ENGINEERING CO. LTD., DALLOW ROAD, LUTON

Sole proprietors of the Marles Steering Company Ltd.

Telephone : Luton 2662 (4 lines) Telegrams : Adamant, Phone, Luton

MARLES



new insulation—light and strong

with **Isocyanates**

and **POLYESTERS** by 

These simple-to-mix components give strong, lightweight rigid foams

to provide an insulating material of particular value in the construction of refrigerated vehicles.

Easily mixed on the site, the components produce the foam in the cavity to be filled.

*As this happens, a bond is formed with the wood or metal with which the foam is in contact
adding strength and rigidity to the structure.*

Ask for details of 'Daltolac' 21 and 'Suprasec' D Enquiries should be addressed to:
I.C.I. Sales Development Department (Polyisocyanates),
Ship Canal House, King Street, Manchester 2.

IMPERIAL CHEMICAL INDUSTRIES LIMITED LONDON SW1 ENGLAND

D.881

KIRKSTALL AXLES

IN USE



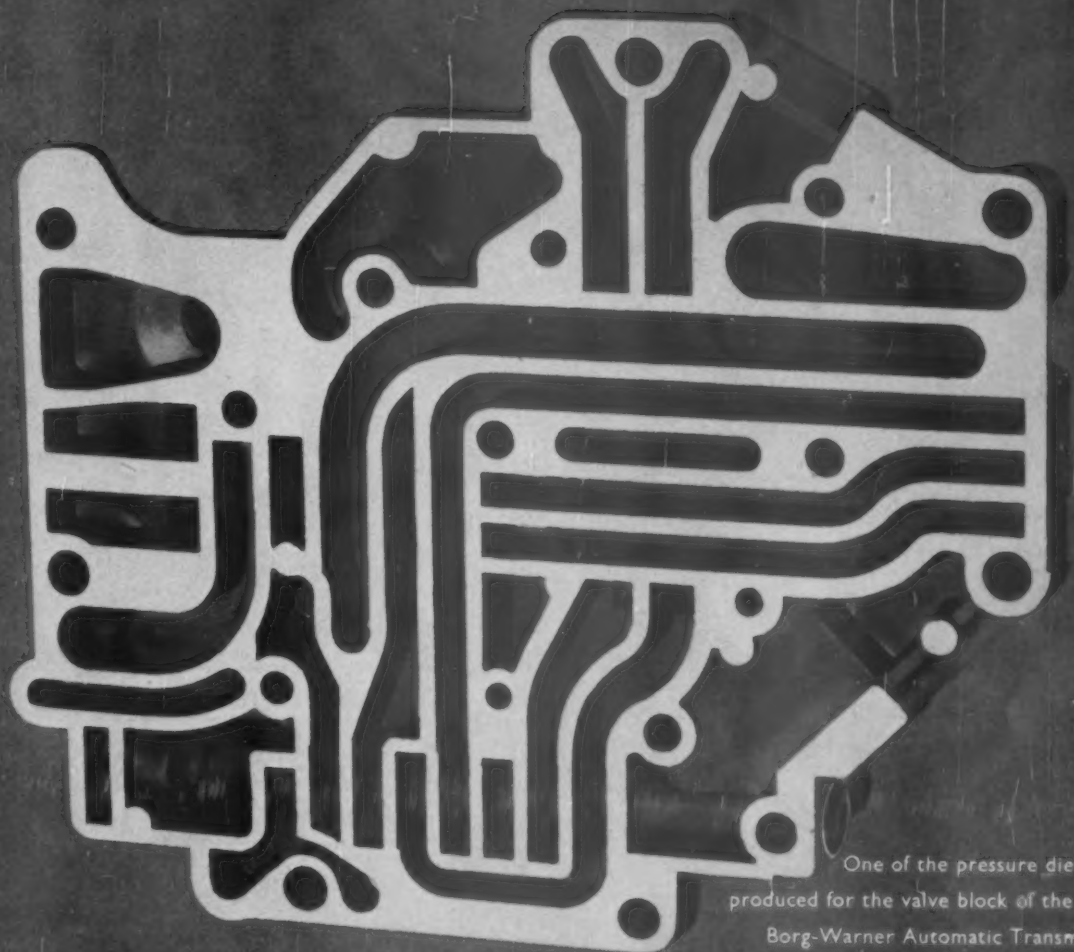
LAYING THE PIPE LINE IN IRAQ

**KIRKSTALL FORGE ENGINEERING
LIMITED** **LEEDS, 5**

Telephone : Horsforth 2821

FP.2.

For all pressure die castings



One of the pressure die castings
produced for the valve block of the
Borg-Warner Automatic Transmission

experience has shown . . .

Hiduminium

makes the most of

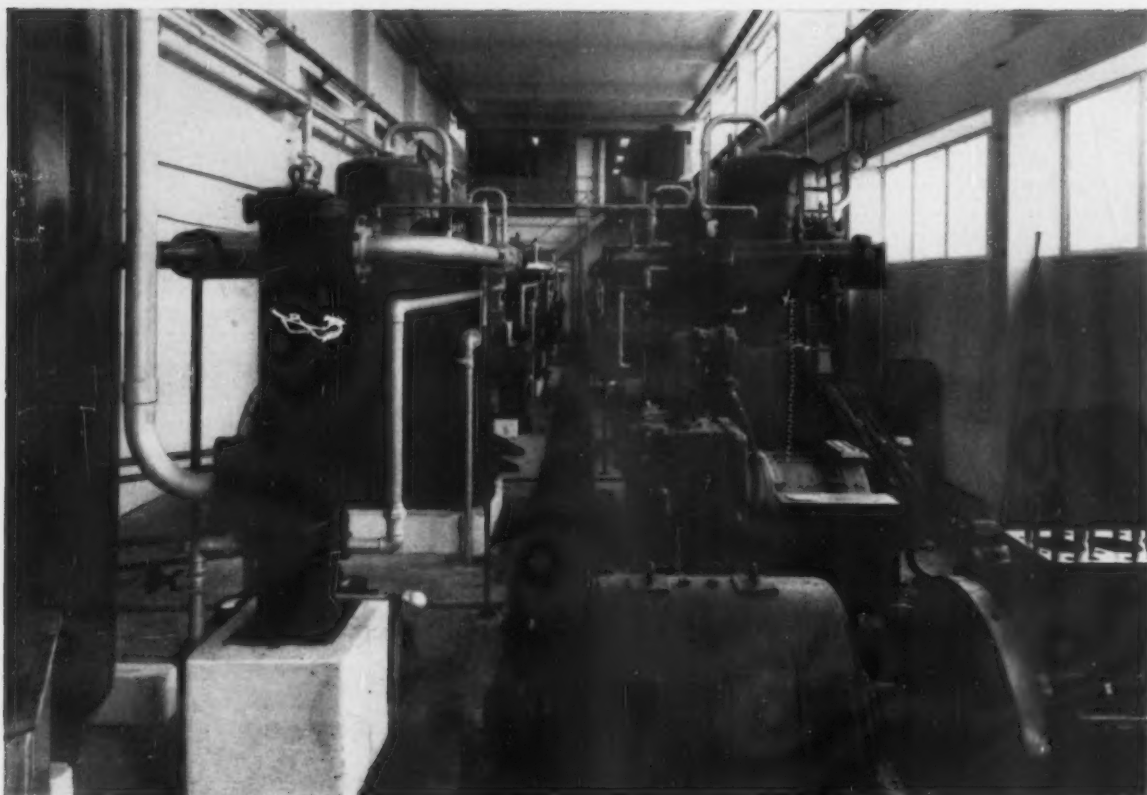
Aluminium

HIGH

DUTY

ALLOYS

LIMITED - ALUMINUM - SUKKA



An installation of six "BROOMWADE" type TS Compressors, one with guard removed to show drive, at the Borg-Warner works, Letchworth.

"BROOMWADE"
in action

... AT BORG-WARNER WORKS

Borg-Warner Limited use six "BROOMWADE" Air Compressors to aid the manufacture and testing of their Automatic Overdrive and Automatic Transmission systems.

For maximum efficiency and economy there's nothing to beat "BROOMWADE." At home and abroad many of the largest manufacturing companies and public authorities have testified to that fact.

"BROOMWADE" Compressors have worked for over forty years with a minimum of overhaul.

"BROOMWADE" Pneumatic Tools are in use on some of the world's largest projects. It certainly PAYS to use "BROOMWADE."

"BROOMWADE"

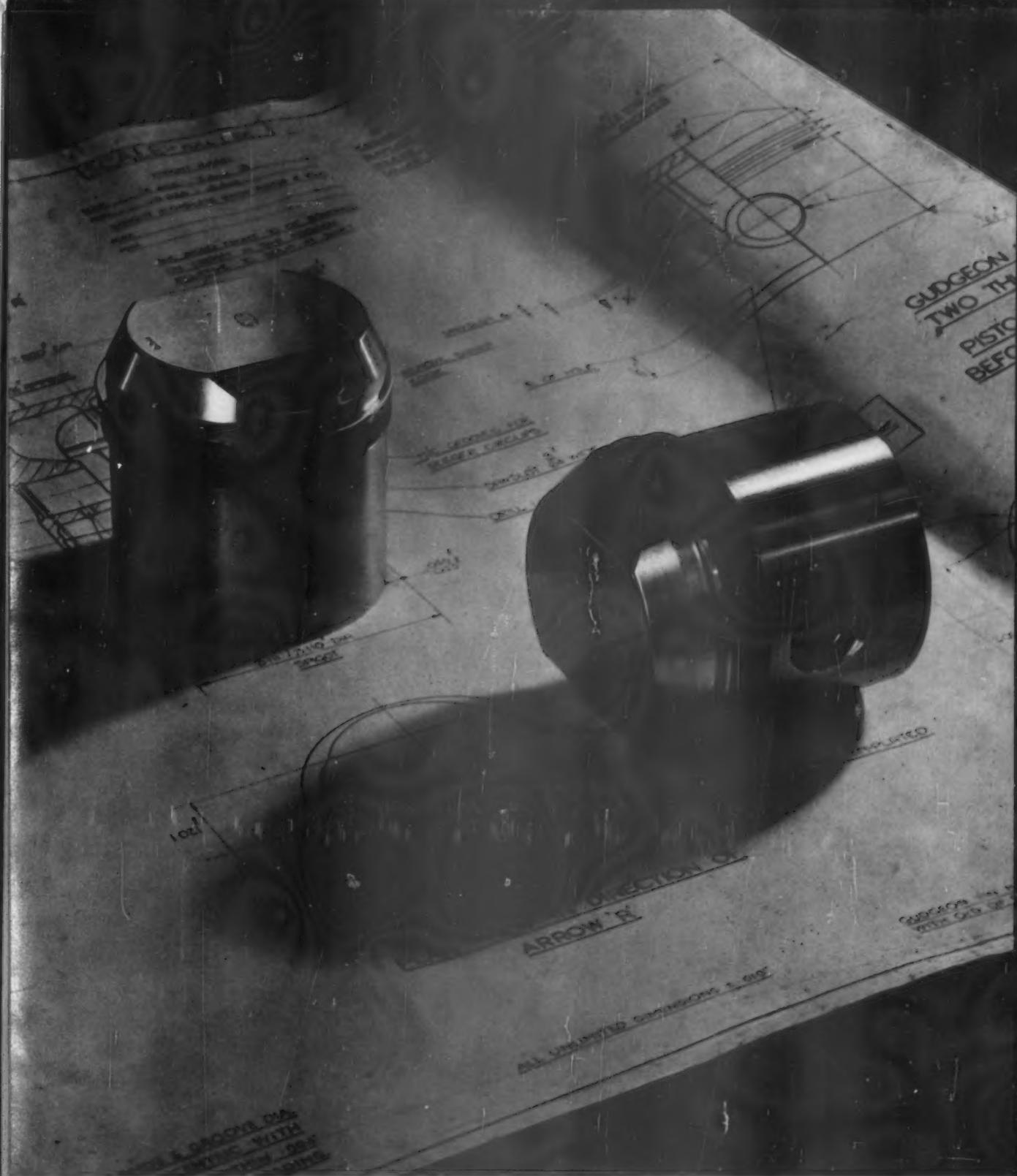
AIR COMPRESSORS & PNEUMATIC TOOLS

Broom & Wade Ltd., P.O. Box No. 7, High Wycombe, England

Telephone : High Wycombe 1630 (10 lines).

Telegrams : "Broom," High Wycombe, Telex.

462 SAS



PISTONS for all the best engines

THE BRITISH PISTON RING CO., LTD., COVENTRY, ENGLAND

The TRADITION *behind*

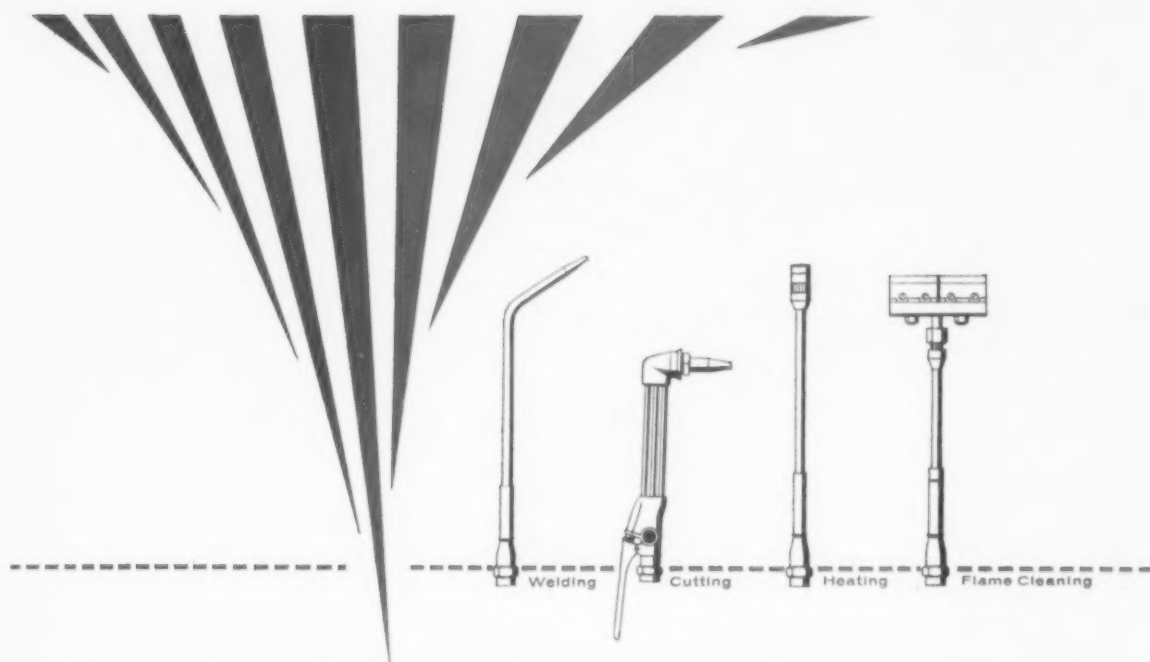


"Well begun"

"Well begun is half done"
runs the old tradition.
At Midcyl, where castings
par excellence are made
by the most modern methods,
inherent craftsmanship is
still the basis of
successful production.

THE MIDLAND MOTOR CYLINDER CO. LTD. SMETHWICK, STAFFS.

FROM BRITISH OXYGEN — FOR BRITISH INDUSTRY



Sensational Saffire 4 blowpipes in 1!



Common Shank
to which any of
these blowpipes
can be fitted.

Recently introduced, the Saffire Combined Outfit has achieved outstanding success and widespread use in industry.

The Saffire, virtually 4 blowpipes in 1, is extremely efficient and economical in use. Here is a precision tool that has helped boost production for many thousands of users.

Buy the whole Saffire Outfit or just the common shank with the heads you need. Just consider how the Saffire Combined Outfit can increase *your own* production range and efficiency!



BRITISH OXYGEN

British Oxygen Gases Ltd., Industrial Division,
Spencer House, 27 St. James's Place, London, S.W.1.

associated with every major achievement



LAND,
SEA,
AIR,
INDUSTRY.

Specialists in
precision gear manufacture.
Gear and spline
grinders for the trade.



The Gear Grinding Co. Ltd.

Makers of the "ORCUTT" range of gear and spline grinding machines and gear measuring machines

CRANMORE BOULEVARD • SHIRLEY • SOLIHULL • WARWICKSHIRE

TeL: SHIRLEY 2231-2-3

SM/GGC 3277/2

what do you know

about



Is it wadding, heavy felt, floss?

Is it easy to handle?

Is it easy to work?

Is it heavy or light?

Other good qualities?

All three — and much more!

'Fibroceta' can be made as a thick, rigid felt ... or as light as swansdown.

Very cohesive — no 'whiskering' — no dust. No damage to skin. And, of course, Bonded 'Fibroceta' is light.

Exceptionally easy (and pleasant!) as a thermal and sound insulant it is supplied in roll or sheet form in widths up to 76". And all Bonded 'Fibroceta' is *eminently suitable for R.F. welding.*

Very light.

It is an excellent sound and thermal insulant. It's not expensive. It is clean, rot-proof, stable under vibration, flexible. In fact — the very characteristics you have been looking for are probably inherent in Bonded 'Fibroceta'!

know more about
versatile



Continual development and experimental research is proceeding on Bonded 'Fibroceta': we shall be glad to co-operate with you in supplying your specific needs.

YOUR ENQUIRIES WELCOMED AT

Courtaulds Limited

'Fibroceta' Courtaulds Acetate Staple

ACETATE DIVISION, POLESKILL ROAD, COVENTRY. TELEPHONE: COVENTRY 26772

10.6

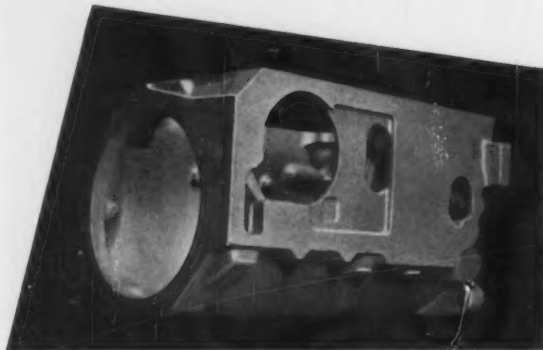
Darcast keeps pace with Progress

The Control and Technique
developed for the production of

High Duty Iron Castings

by the Darcast Foundries

is ready to meet developments
of the Motor Industry.



AUTOMATIC GEARBOX CASE (COURTESY OF ROLLS-ROYCE LTD)



BRAKE DISC (COURTESY OF DUNLOP RIM & WHEEL CO LTD)



COMPOSITE STEEL & CAST IRON BRAKE DRUM
(COURTESY OF VAUXHALL MOTORS LTD)

DARCAST

DARTMOUTH AUTO CASTINGS LIMITED
SPECIALISTS IN HIGH DUTY IRON CASTINGS FOR THE MOTOR INDUSTRY

**SMETHWICK 40
BIRMINGHAM**

AUTOMOBILE ENGINEER

CONTENTS



THIS COLLET CHUCK IS SPECIFICALLY DESIGNED FOR THE RECENTLY INTRODUCED BURNERD "MULTISIZE" COLLETS, EACH OF WHICH HAS DIMENSIONAL FLEXIBILITY EXTENDING OVER 0.125 IN. OF WORK DIAMETER

Published the second Wednesday in every month
by ILIFFE & SONS LIMITED
Dorset House, Stamford Street, London, S.E.1
Telephone · Waterloo 3333 (60 lines)
Telegrams · Sliderule, Sedist London
The annual subscription inland and overseas
is £3 0s 0d including the special number
Canada and U.S.A. \$8.50

BRANCH OFFICES
Coventry · 8-10 Corporation Street
Telephone · Coventry 5210
Birmingham · King Edward House, New Street, 2
Telephone · Midland 7191
Manchester · 260 Deansgate, 3
Telephone · Blackfriars 4412 and Deansgate 3595
Glasgow · 26a Renfield Street, C.2
Telephone · Central 1265

- 1 Editorial *The Future Outlook*
- 2 Air Suspension on the Continent *Products of the component suppliers, and a discussion of some features of their design and application to commercial vehicles*
- 12 Engine Testing *Specially designed equipment for technical colleges and training establishments*
- 14 New Plant and Tools *Recent developments in production equipment*
- 17 Plastic-coated Steel *New material by John Summers and Sons Ltd., can be bent, formed, drawn, seamed and welded*
- 19 Engine Lubrication *Tests on a compound based on molybdenum disulphide*
- 21 Safety Belts *Details of a device to minimize injury*
- 22 Diesel Engine Performance *M. Alperstein, W. B. Swim, P. H. Schweitzer A technique for reducing smoke and improving output*
- 32 Latham Supercharger *An axial flow unit designed for quantity production economically with conventional tools*
- 34 Sintered Bronze-faced Clutch Plates *Production of components for the Borg-Warner automatic transmission at Sintered Products Ltd.*
- 38 Balancing Engines *A Ford development in America*
- 39 Foreign Publications *Brief reviews of current technical books*
- 41 Current Patents *A review of recent automobile specifications*

offers a unique range of ball friction bearings
as well as advice on their application to ensure the use

VOL 48

1

AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 48 No. 1

JANUARY 1958

PRICE: 3s. 6d.

ENGINEERING
LIBRARY

FBC SPECIALS

... the key to a fuller life

There are many designs in which an FBC 'Special' has saved the situation.

Sometimes new developments take such a form that standard bearings will not fit in; in other cases performance has been stepped up to such a pitch that the original standard bearings are no longer man enough for the job.

That is where FBC 'Specials' come in. Special sizes of bearings can be produced to suit the restricted space available: Or bearings of standard dimensions can be developed to carry loads—or to cope with speeds—far above those within the capacity of the standard bearings.

It is amazing what exacting duties can be carried out by the right kind of bearing, when one is really 'up against it' and enlists the aid of the right people.

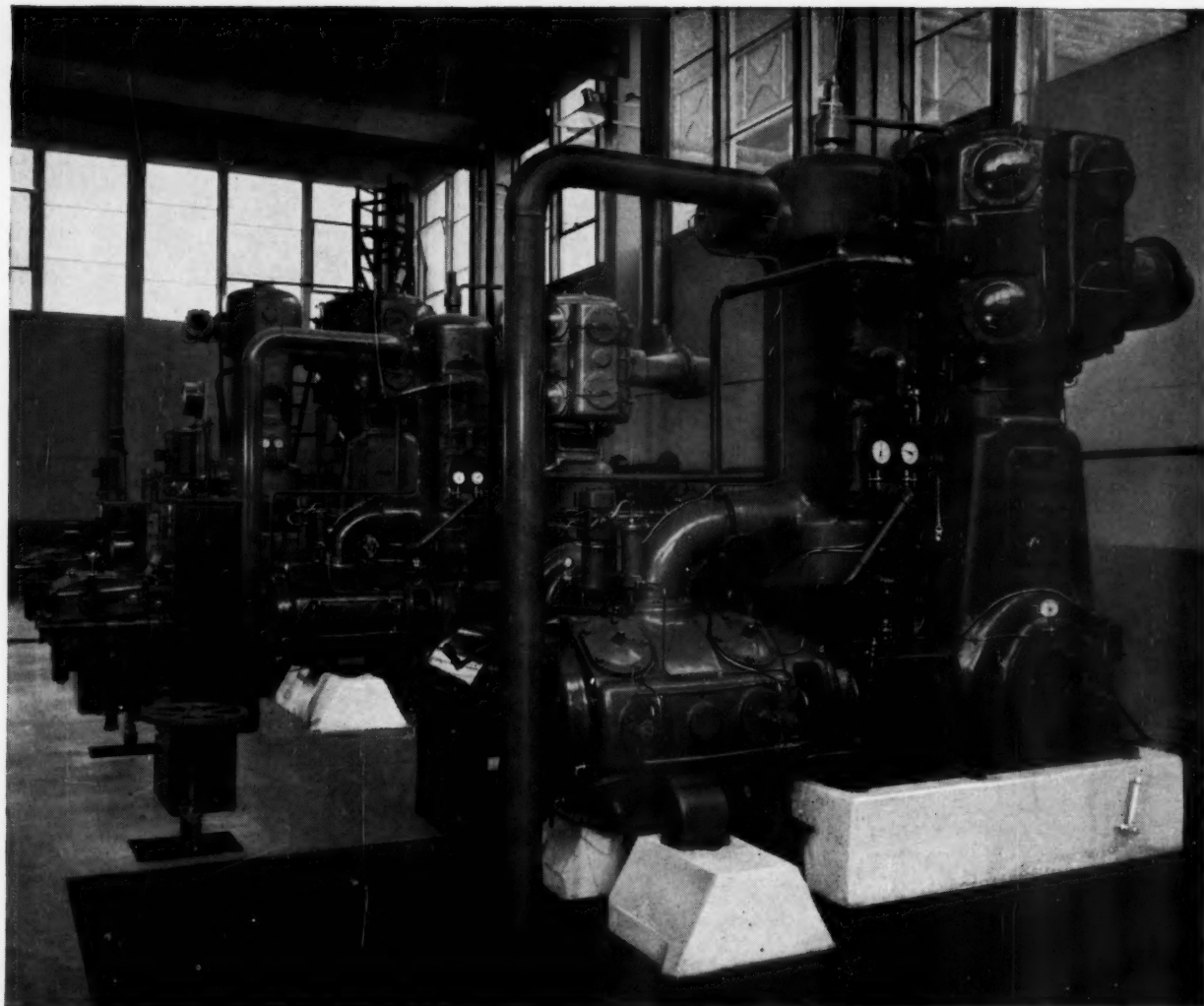
Our engineers—to whom, of course, we have just referred—will always assist in the design and manufacture of 'Specials' to suit customers' problems.

FISCHER BEARINGS CO. LTD., WOLVERHAMPTON
Fischer Bearings Company Ltd., and Timken-Fischer Stockists Ltd., Birmingham,
are both subsidiaries of British Timken Ltd.

FBC FISCHER
Regd. Trade Marks

FBC

ALL-BRITISH
BALL AND
PARALLEL-ROLLER BEARINGS
F.B.C. FISCHER



Atlas Copco compressors provide air for British car body firm

When the new 400,000 sq. ft. Swindon plant of Britain's Pressed Steel Company Limited was planned, the compressor installation was naturally of prime importance. Two Atlas Copco AR7 compressors were installed and have been running trouble free, nine hours a day, 5 days a week since January 1956 and an AR9 has recently been installed to meet the steadily increasing demand.

They supply compressed air, first, for the clutch control and balancing of power presses ranging up to 1,000 tons capacity: second, for the spot welding guns and other air tools in the Company's machine shop.

At 100 lbs/sq. in. the free air delivery of the 318 hp AR7 is 1,740 cfm. The output of the 586 hp AR9 is 3,210 cfm.

This means that only 18.3 hp is required for every 100 cu. ft. of air delivered per minute at 100 lbs/sq. in., and this extremely high efficiency has impressed industrial planners not only at the Pressed Steel Company but throughout the world.

WORLD-WIDE SALES AND SERVICE

The Atlas Copco Group puts compressed air to work for the world. It is the largest group of companies specialising solely in the development and manufacture of compressed air equipment. It embraces Atlas Copco companies or agents manufacturing or selling and servicing Atlas Copco equipment in ninety countries throughout the world. For further details, contact your local Atlas Copco Company or Agent, or write to Atlas Copco AB, Stockholm 1, Sweden, or Atlas Copco (Great Britain) Limited, Beresford Avenue, Wembley, Middlesex.

Atlas Copco *Manufacturers of Stationary and Portable Compressors, Rock-Drilling Equipment, Loaders, Pneumatic Tools and Paint-Spraying Equipment.*

c19

AUTOMOBILE ENGINEER

CONTENTS

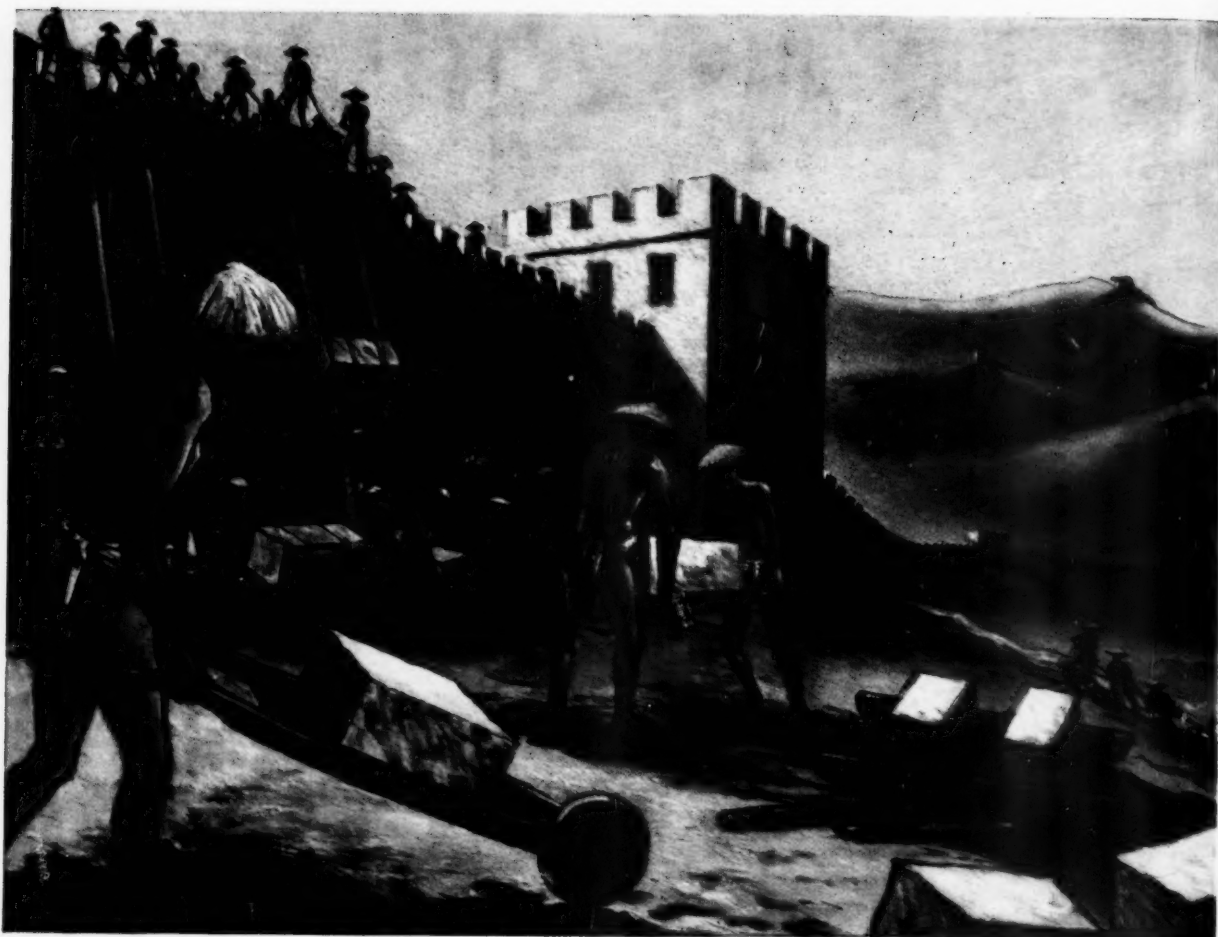


THIS COLLET CHUCK IS SPECIFICALLY DESIGNED FOR THE RECENTLY INTRODUCED BURNERD "MULTISIZE" COLLETS, EACH OF WHICH HAS DIMENSIONAL FLEXIBILITY EXTENDING OVER 0.125 IN OF WORK DIAMETER

Published the second Wednesday in every month
by ILIFFE & SONS LIMITED
Dorset House, Stamford Street, London, S.E.1
Telephone · Waterloo 3333 (60 lines)
Telegrams · Slidrule, Sedist London
The annual subscription inland and overseas
is £3 0s 0d including the special number
Canada and U.S.A. \$8.50

BRANCH OFFICES
Coventry · 8-10 Corporation Street
Telephone · Coventry 5210
Birmingham · King Edward House, New Street, 2
Telephone · Midland 7191
Manchester · 260 Deansgate, 3
Telephone · Blackfriars 4412 and Deansgate 3595
Glasgow · 26a Renfield Street, C.2
Telephone · Central 1265

- 1 Editorial *The Future Outlook*
- 2 Air Suspension on the Continent *Products of the component suppliers, and a discussion of some features of their design and application to commercial vehicles*
- 12 Engine Testing *Specially designed equipment for technical colleges and training establishments*
- 14 New Plant and Tools *Recent developments in production equipment*
- 17 Plastic-coated Steel *New material by John Summers and Sons Ltd., can be bent, formed, drawn, seamed and welded*
- 19 Engine Lubrication *Tests on a compound based on molybdenum disulphide*
- 21 Safety Belts *Details of a device to minimize injury*
- 22 Diesel Engine Performance *M. Alperstein, W. B. Swim, P. H. Schweitzer A technique for reducing smoke and improving output*
- 32 Latham Supercharger *An axial flow unit designed for quantity production economically with conventional tools*
- 34 Sintered Bronze-faced Clutch Plates *Production of components for the Borg-Warner automatic transmission at Sintered Products Ltd.*
- 38 Balancing Engines *A Ford development in America*
- 39 Foreign Publications *Brief reviews of current technical books*
- 41 Current Patents *A review of recent automobile specifications*



The Conquest of Friction

The Wheel is so old that its origins are beyond human knowledge. The transition from the rolling of heavy loads on logs to the mounting of a short length of log on an axle to make a wheel was, however, a fundamental invention.

Legend persists that the Chinese first devised the wheel, as indeed they were responsible for many other innovations of civilization.

Thousands of years later the innovation of the self-aligning ball bearing marked another major advance in the conquest of friction — and laid the foundations of the world-wide **SKF** organisation, which today offers a unique range of anti-friction bearings as well as advice on their application to ensure the use of the right bearing in the right place.



SKF



THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS

THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

G146

Editor J. B. Duncan

Editorial Staff T. K. Garrett, A.M.I.Mech.E. A.F.R.Ae.S. (Associate Editor)

F. C. Sheffield

DESIGN MATERIALS

AUTOMOBILE ENGINEER

PRODUCTION METHODS

WORKS EQUIPMENT

The Future Outlook

THAT today the outlook is brighter for the British automobile industry than it was at the beginning of 1957 is something for which we can all be thankful. The upsurge in demand that occurred in the last six months of last year has been gratifying and heartening. Even, however, in the early months of 1957 when demand was falling seriously, automobile manufacturers did not lose confidence in the long term. Tremendous expansion plans were continued, although in some cases at a slower tempo, and now the general opinion is that, apart from major political or economic upheavals, the industry can more than hold its own against foreign competition.

These columns are not concerned with political questions, except in so far as they affect the well-being and prosperity of the industry. There is, however, one political matter to which we have referred before and must now refer again. A *sine qua non* for an industry that produces in large quantities for a very competitive market is that there must be a large home market that can take up any excess production when there are recessions in export markets. On this matter it is apposite to quote an independent opinion. In "Britain and Europe," a report prepared by The Economist Intelligence Unit on the probable effects of a European Free Trade Area, it is written that "The cost-reducing effect of an expansion of output may easily swamp increases in raw material or labour costs. This has been the case in France where the level of wages and raw material prices is very high indeed but where efficient productive organization and fuller utilization of capacity have kept costs to a very competitive level. In the long run, costs per unit of output may depend very much more upon the degree of capitalization and the size of the domestic market than upon the price structure of the economy as a whole."

So far as the technical outlook is concerned there is every reason to believe that just as current British road vehicles hold their own against their Continental competitors so will future designs. In general, it is true to say that for several years to come development will consist in modifications of existing design patterns rather than in radical changes.

In the case of power units there is not the slightest evidence that anything will replace the piston engine in the near future, nor for the time being that direct fuel injection will be adopted in place of carburation, except, perhaps, for sports cars and some expensive passenger cars. However, the trend towards higher compression ratios will

call for very careful attention to combustion chamber design and breathing characteristics.

There is no doubt that two-pedal control, with either semi-automatic or full-automatic transmission, will soon be the rule rather than the exception. The day of the conventional gearbox with conventional gear-shift is not yet past but it is passing. This was evident at the 1957 Earls Court Motor Show where only one major British manufacturer failed to show at least one model with some form of two-pedal control.

In the case of suspensions, major advances and developments are much more likely for public service and heavy commercial vehicles than for passenger cars. A pointer showing what may be expected was afforded by the 1957 Frankfurt Show, where almost every German manufacturer of heavy vehicles showed at least one model with pneumatic suspension. This type of suspension is particularly suitable for public service vehicles. Its principal advantage is that when used in conjunction with an automatic height regulator, optimum use is made of the space available for wheel deflection regardless of the load carried. In other words, lightly laden or heavily laden the ride is the same. The improved ride makes it attractive for private cars also, but at the moment the need for a compressor is a serious obstruction to its use on passenger cars. Pneumatic suspension, however, offers so many advantages that we cannot afford to let Continental competitors get ahead of us in its use. Fortunately, several British manufacturers have either developed or are developing pneumatic suspension systems.

More efficient engines and improved suspensions will inevitably lead to higher road speeds; improved braking will therefore be necessary. There is, of course, a limit to the size of drum-type brake that can be accommodated within the dimensional limitations imposed by the wheel rims; this may lead to the wider use of disc brakes, particularly on commercial vehicles equipped with air suspension. An increased demand for disc brakes could appreciably reduce the cost-factor advantage now possessed by drum-type brakes.

Cars, smaller than anything they now produce, have been and will likely continue to be the subject of careful study by several major manufacturers. There is considerable divergence of opinion concerning the market for these cars, but in our opinion if such a vehicle is to win wide acceptance in this country, it must be equipped with an engine of not less than 600 cm³.

Air Suspension on

Products of the Component Suppliers, and a Discussion of Some Features of Their Design

IN the air suspension systems on the vehicles that were described in Part I of this article, the individual components, such as springs and height regulator valves, are supplied by many different manufacturers, most of whom are primarily engaged in the production of tyres and other rubber components. The majority of these firms are associated with companies both in this country and in America, and in all three countries development has been proceeding on parallel lines and there has been a great deal of interchange of information. It follows, therefore, that similar components are in many instances produced in both this country and America.

Bosch

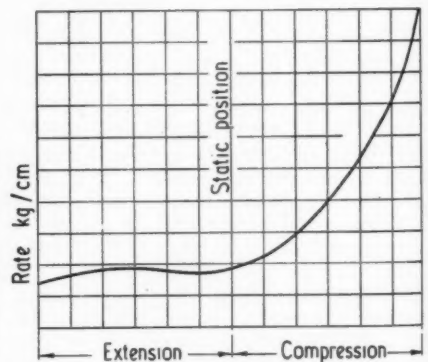
Bosch G.m.b.H., of Stuttgart, are developing height regulator valves for air suspension systems. The designs of some of these valve units are not yet finalized and patents are pending, therefore few details are so far available. In general principle, they function in the following manner. Movement of the actuating lever does not immediately actuate the valve, because the motion of the valve is hydraulically damped and there is a flexible element incorporated between the spindle actuated by the lever and the spindle that actuates the valve. An adjustment screw is provided so that the delay period between the movement of the actuating lever and the operation of the valve can be regulated to any period from zero to 20 sec. This adjustment device is simply a conical-ended screw, which projects into and restricts the transfer duct through which the hydraulic fluid passes from one side of the damper piston to the other.

The general arrangement of the valve assembly is not unlike that of the Westinghouse hydraulically damped valve, shown in an accompanying illustration. That is, the air valve and damper piston assembly are mounted one above the other, with their axes parallel, and tongues on them register in slots in a drum, which is rotated by the actuating lever: the axis of this drum is at right angles to the plane containing the axes of the air valves and the damper piston assembly.

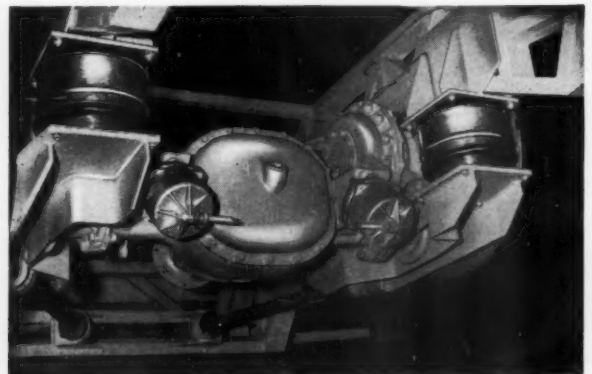
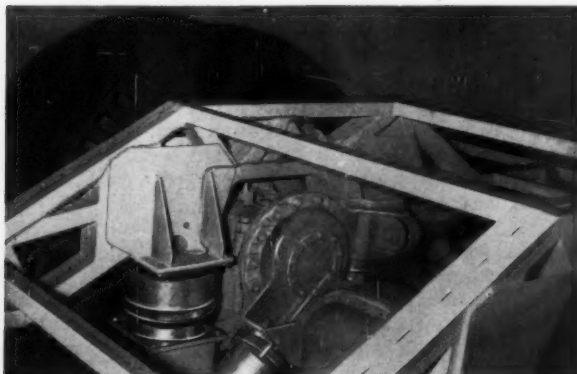
This article is the sequel to one published in the December 1957 issue of Automobile Engineer. In the first part, the general principles of air suspension and some of the layouts employed on the Continent were discussed. This second part goes on to describe the individual components and deals with some of the problems involved in their design. The article ends with a few comments on two systems that are of particular interest because they require neither a compressor nor any other source of air.

However, the Bosch arrangement differs from the Westinghouse unit in that, as has already been mentioned, the flexible element is interposed between the spindle of the actuating lever and the drum that moves the valve and damper, instead of being incorporated in the actuating linkage. The Bosch element comprises simply three steel balls, which seat between three conical recesses in the end face of the drum and three more in a disc, the disc being spring-loaded against the drum. When the actuating lever is moved, it rotates the retainer disc and, since the valve is damped and therefore cannot immediately move,

Typical characteristic curve of the CEAT Air Spring, showing how a low and relatively constant rate is obtained over a large portion of the working range and the rate rises steeply towards the full bump position



In the two views below, of an air suspension mock-up exhibited on the Viberti stand at the Turin Show, the trailing locating links with spherical rubber end-fittings can be seen. CEAT Air Springs are used and, in conjunction with this double-reduction rear axle, they form a very compact installation

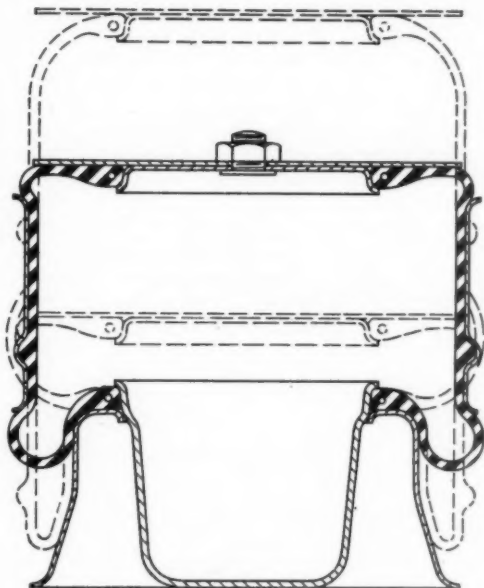


the Continent

and Application to Commercial Vehicles

the conical recesses in the retainer disc move out of alignment with those in the drum, so that the balls ride up their conical surfaces, pushing the retainer plate axially away from the end face of the drum. In this condition, since the spring is tending to force the retainer plate back towards the end face of the drum, the balls are tending to roll down the conical surfaces into their seats. It follows that the seating of the balls can only be effected by rotation of the drum which, in turn can take place only when the damper piston has had time to move the appropriate distance so that the valve can open.

In addition to the valves through which air is supplied



This CEAT Air Spring has an auxiliary air tank, formed by a cupped pressing, in the piston secured to the base of the rubber cylinder

to the spring and released again as required, there are two more in this height regulator valve assembly. One is to prevent the springs from deflating in the event of failure of the pressure supply system. The other is to prevent the air from escaping from the brake system through the air springs in the event of a leakage either from the rubber bellows or from the pipe lines that serve them.

CEAT

In Italy, CEAT-Gomma, of Turin, are producing under licence the Air Spring, which is a registered trade name of the General Tyre and Rubber Co., of America. They state that a wide range of standard sizes is available and that, in addition, special sizes can be designed for particular applications. An unusual feature of the CEAT version of this system is that apparently there is no hydraulic damping

to delay the action of the levelling valve. It seems likely, however, that damping is effected by restriction of the air passages in the valve. The manufacturers state that the oscillation of the valve, owing to either vertical displacement of the suspension or rolling of the body, automatically causes air to flow from the reservoir to the spring or to escape from the spring, as appropriate, so that not only is the height of the sprung mass maintained as nearly constant as possible, but adjustments are also made automatically to correct for any tendency to roll during cornering. The disadvantage of the employment of air valves that are not damped hydraulically is, of course, that the air consumption rate tends to be high and the wear and tear on the valves is greater than when damped valves are employed. Undesirable oscillations have been known to occur as a result of undamped air surges caused by repeated valve operation at certain frequencies.

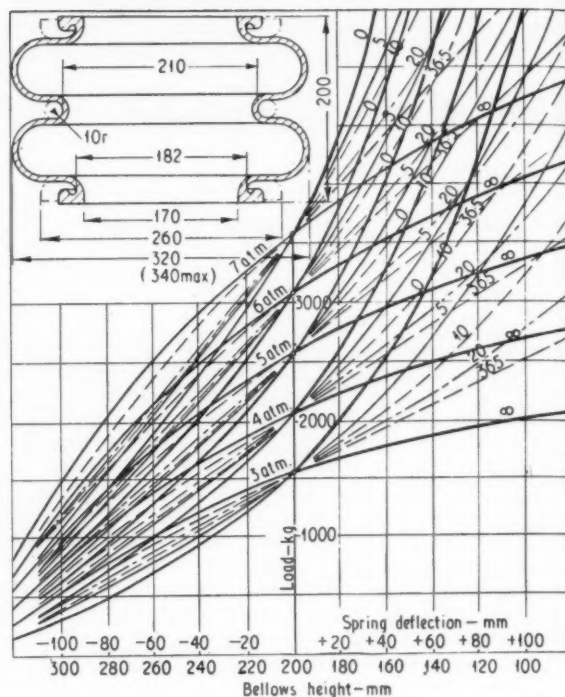
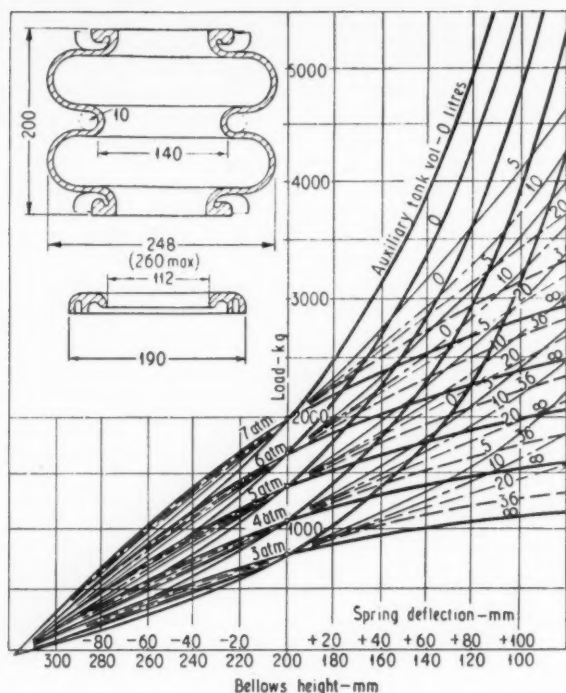
A cross section of the Air Spring is shown in an accompanying illustration. It comprises a cylindrical chamber of rubber reinforced with woven nylon. The cylindrical wall of the chamber is surrounded and reinforced by a steel sleeve, to prevent it from bulging under pressure. There is a hole in each end of the chamber, and the edge of this hole is beaded and reinforced with a steel ring. Clamped to the beading at one end is a circular plate, and to that at the other end is secured a pressed steel piston. A pipe connection, from a hole in the centre of the end plate, is taken to the height regulator valve. The auxiliary reservoir is formed by a cupped steel pressing inserted into a hole in the crown of the piston in such a way that its open end is in communication with the cylindrical chamber.

In most installations, the end plate seats under the chassis frame, and the piston is attached to the suspension yoke or link. Therefore, as the wheels rise and fall, the piston moves in and out of the cylinder, the lower end of rubber wall rolling up and down with it. The piston is shaped in such a way that the rate of change of volume of the air in the cylinder varies according to deflection: it can be arranged to suit any particular application. In the illustration showing a typical spring characteristic, it can be seen that the rate increases rapidly as the maximum permissible deflection is approached.

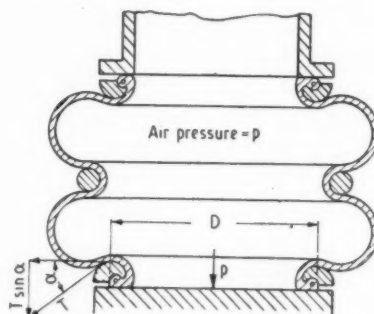
Continental

Continental Gummi-Werke A.G. manufacture air springs, of the cylindrical bellows type, the general principles of which have been described in the September 1957 issue of *A.T.Z.* As can be seen from the accompanying illustration, these springs are mostly of the double-convolution type, the two convolutions, or cells, being separated by a circular section, steel ring. This arrangement enables a relatively large range of vertical deflection to be obtained while, at the same time, the diameter of the spring varies little. If the spring is used without an auxiliary air tank, each of its ends is clamped on to its seat by means of a steel ring. However, if an auxiliary tank is used, it generally takes the form of a steel cylindrical extension of the rubber bellows. One end of this cylinder is closed and the other is flanged to form one of the seats for the rubber bellows.

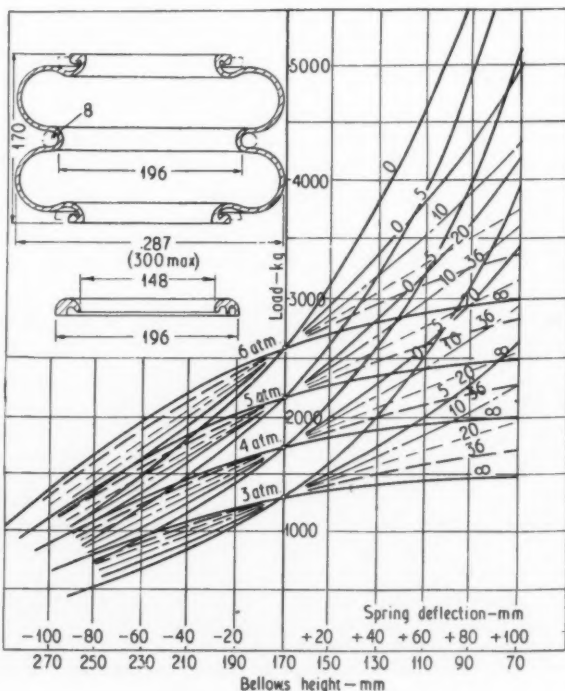
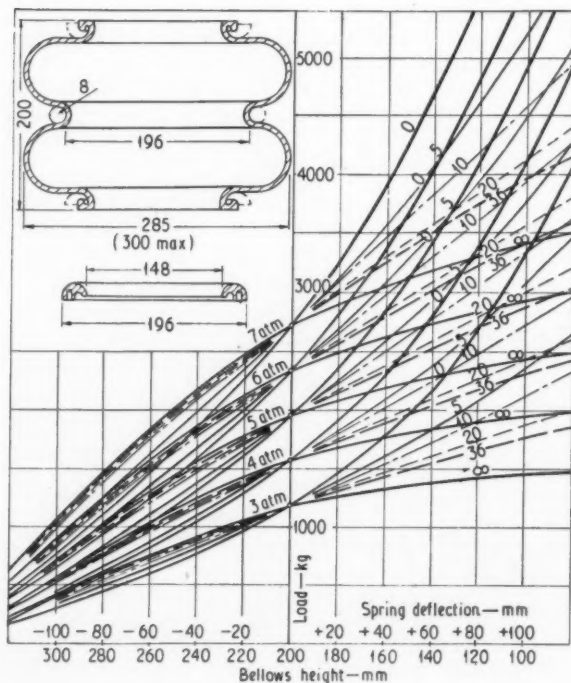
From the illustration of the Continental pneumatic spring, it can be seen that the load P that it can support is dependent on two variables. One is the effective plan area of the seat, multiplied by the pressure, $\pi D^2 p / 4$, and the other is the vertical component of the tension in the walls of the bellows, $T \sin \alpha$. The symbols used in these expressions are clearly defined in the illustration. So far as the term $\pi D^2 p / 4$ is concerned, it is clear that if the ring clamping the end of the spring on to its seat is of wide cross section, so that the effective area of the seat increases with spring deflection, a rising spring rate is obtained. On the other hand, with a thin ring, this seating ring form-factor is virtually constant.



The illustration on the right shows how the rate of the Continental pneumatic spring is dependent upon the air pressure times the plan area of the seat, plus the vertical component of the tension in the cylindrical walls of the rubber bellows. In this illustration, part of the auxiliary reservoir is shown sectioned above the spring



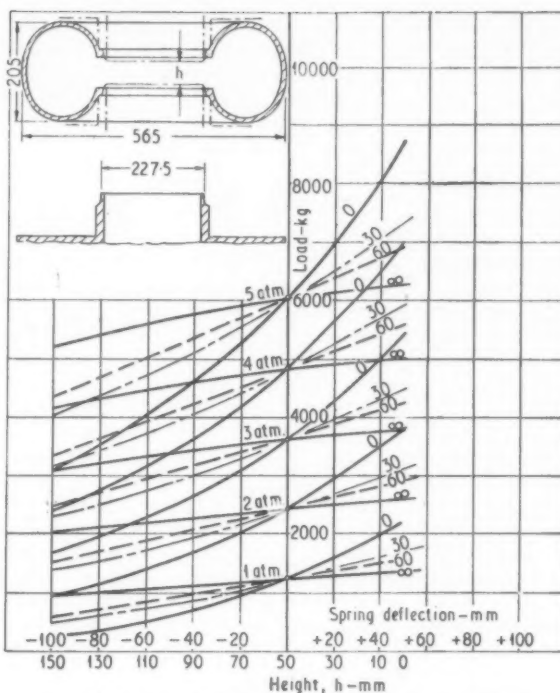
The four sets of curves on this page and the two sets on the opposite page show how the characteristics of the Continental pneumatic springs can be regulated by the employment of bellows and seating rings of different proportions. On each set of curves, the linear dimensions are given in millimetres and the auxiliary tank volumes in litres



Since α is continually changing, the second term, which might be called the *bellows form-factor*, varies continuously with deflection. The way in which α changes can be regulated to a certain extent by altering the amount by which the periphery of the bellows overhangs that of the seating ring. With a small overhang and a seating ring of wide section, a steeply sloping load deflection curve can be obtained. This slope can be reduced appreciably by increasing the overhang; and a relatively flat curve can be obtained with a large overhang and a ring of narrow section. The width of the ring section affects mostly the lower portion of the load-deflection curve, while the degree of overhang tends to influence almost the whole range, particularly if a narrow section seating ring is employed. A wide section ring is generally employed so that the compression force on the spring will decrease rapidly as the suspension moves to the rebound position.

Yet another factor affects the variation of spring rate, with deflection. This is the fact that, for rapid deflections, the air in the spring is compressed adiabatically, according to the law $pV^n = \text{constant}$, where p is the absolute pressure, V is the volume of air compressed and n is the ratio of the specific heat of air at constant pressure to that at constant volume. It follows that $p_2/p_1 = (V_1/V_2)^n$, where the suffices 1 and 2 refer respectively to the conditions before and after deflection. Thus it can be seen that the greater the ratio of $V_1 : V_2$, the more steeply will the load deflection curve rise as deflection increases; in other words, an air spring used without an auxiliary tank will have a more steeply rising characteristic than one with such a tank. Therefore, the slope of the load deflection curve can also be regulated by varying the size of the auxiliary tank.

The effects of all these variables can be seen in the set of six curves, showing the characteristics of springs of different detail design. These curves show that, unless low pressures and therefore unduly large springs are employed, the rate increases too rapidly with deflection when the springs are not used in conjunction with an auxiliary tank. At the other extreme, if an auxiliary tank of infinite volume is employed in conjunction with this type of spring, the load deflection curves are too flat for most applications, particularly at the



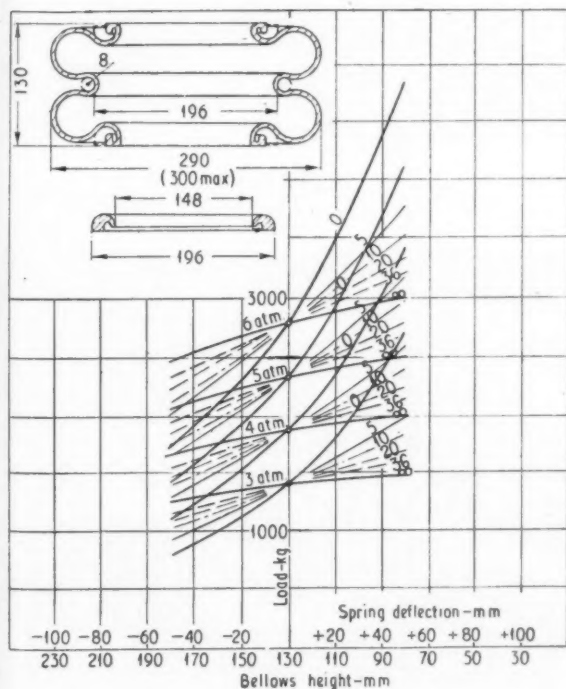
upper end of the deflection range, where the bellows form-factor is almost a constant, unless impracticably high pressures are adopted. It is of interest to note that when the auxiliary volume is infinity, the variations in the slope of the curves are entirely due to the seating ring and bellows form-factors. In practice, of course, the volume of the auxiliary air tank chosen is the compromise, between the extremes of zero and infinity, which gives the required load deflection characteristics and a convenient pressure.

Dunlop

The Deutsche Dunlop Gummi Compagnie A.G., of Hannau am Main, have done a great deal of development work on air suspension systems. They claim that with their system, the air consumption is extremely small because the height regulator valve operates only to correct for load variations, and it can therefore be employed for passenger cars, even if a compressed air bottle is installed to act as the source of supply for the pneumatic system. In practice, the air pressure in the springs seldom exceeds 5-6 atmospheres, but the highest pressure that the springs are capable of carrying is 7 atmospheres.

Several layouts are envisaged. Among these are systems in which both the front and rear axles are located by V-links and Panhard rods. The apex of the V-link is pivoted on the vehicle frame, while its splayed ends, which are attached to a beam axle, form the seats for the lower ends of two cylindrical, double-convolution bellows pneumatic springs. Two shock absorbers of conventional size are employed on each axle. Cylindrical, auxiliary air tanks form the seats for the upper ends of the springs.

An alternative arrangement for a single-axle rear suspension system is as follows. The conventional leaf springs are replaced by longitudinal beams, the ends of which are swept round in front of and behind the rear wheels, to carry the lower seating pads for the four, cylindrical, double-convolution bellows type, pneumatic springs. This gives a wide spring base, but presumably cross members would be required between the swept ends of these beams. Location of the axle is effected by two trailing links and a V-link. The apex of the V is pivoted on top of the axle casing, while its ends are pivoted on the vehicle frame. One trailing link is



pinned between lugs below each end of the axle; the other ends of these links are pivoted on downward-extending brackets under each side member of the frame. The illustration of this system, in the lower right-hand corner of the opposite page, is of a model shown on the Dunlop stand at the Frankfurt Show.

Knorr-Bremse

Knorr-Bremse G.m.b.H., of Munich, manufacture a height regulator valve for air springs. As can be seen from the accompanying diagram and the detailed illustration of the unit, movement of the actuating arm rotates a cam, which applies a torque to the valve operating rocker. However, since this rocker is connected at one end to the piston of a hydraulic damper, it cannot move immediately. Instead, the cam compresses a pair of spring-loaded plungers housed in the centre of the rocker. Continued application of the torque, through the spring-loaded plungers to the rocker, causes the piston of the damper to move slowly in its cylinder, displacing oil through a transfer port from one side of the piston to the other. This allows the valve actuating rocker to rotate about the cam spindle, on which it is mounted, until the plungers are fully extended again. In this condition, the rocker bears on the end of one or other of the two valve stems, according to the direction of the applied torque. One of these valves regulates the entry of compressed air to the spring, while the other controls a port to atmosphere. The transfer passage from one side of the damper piston to the other has a conical-ended metering screw in it. Adjustment of this screw determines the delay period before the appropriate valve is opened. In the illustration of a mock-up of a swing axle suspension system, produced for display purposes, the Knorr-Bremse height regulator valve is shown in the foreground to the left of the spring. The radius rod, which guides the swing axle, is just visible behind the spring.

Metzeler

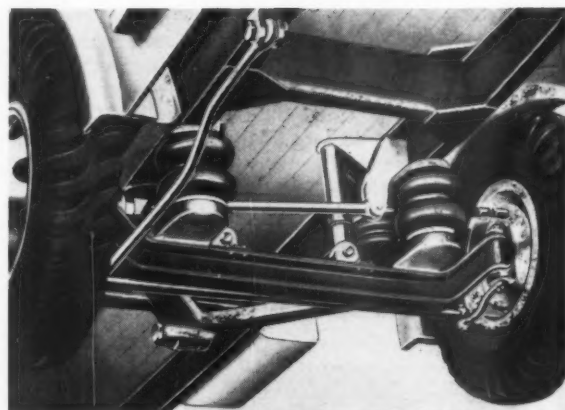
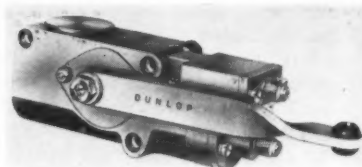
The Metzeler Gummiwerke A.G., of Munich, manufacture a spring similar to the CEAT unit already described. In the accompanying diagrammatic illustration, it is shown installed in a typical motor car front suspension system. The spring comprises a closed cylinder of rubber reinforced with cord plies, like a tyre, and a pressed steel piston of conical form, which moves in and out of its lower end, rolling the lower end wall of the cylinder with it, as the wheel rises and falls. A steel sleeve reinforces the periphery of the cylinder. The conical form of the piston gives a spring rate that progressively increases with deflection of the assembly.

The advantages claimed for this spring are that it enables a larger deflection to be obtained than is practicable with either circular bellows or elongated bags; it is compact; almost instantaneous operation is obtained, and it is said to have a long life. As can be seen from the illustration in the top right-hand corner of the opposite page, this type of spring is well suited for application to a transverse wish-bone type front suspension. In fact, it might even be practical to substitute it for the coil spring in an existing suspension system, provided the diameter of the pneumatic spring is not too great. This spring is, of course, equally well suited to other suspension arrangements.

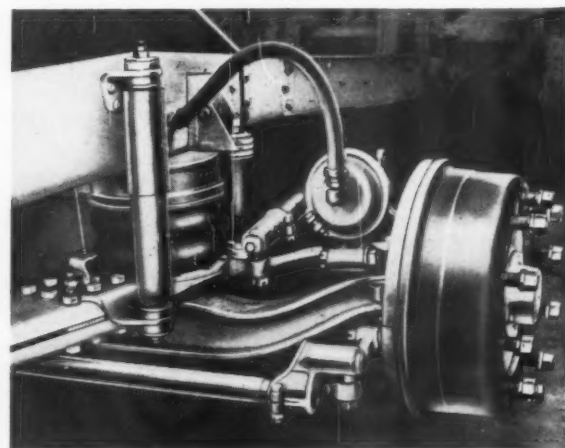
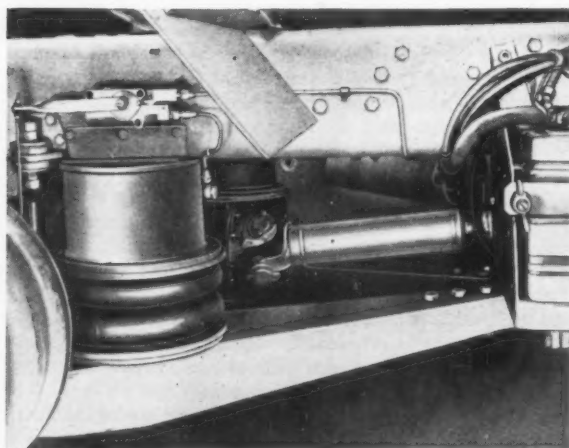
Phoenix

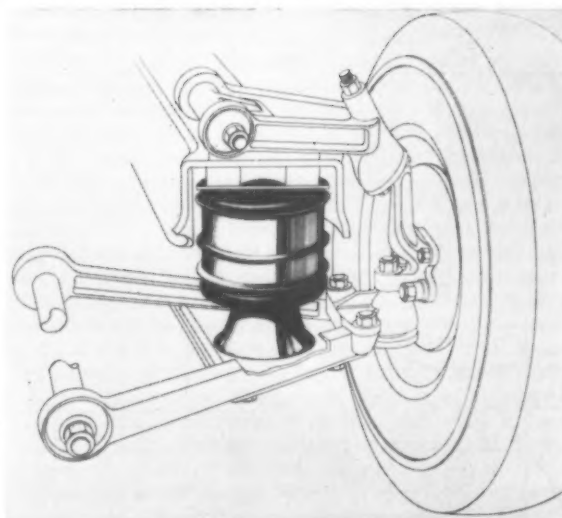
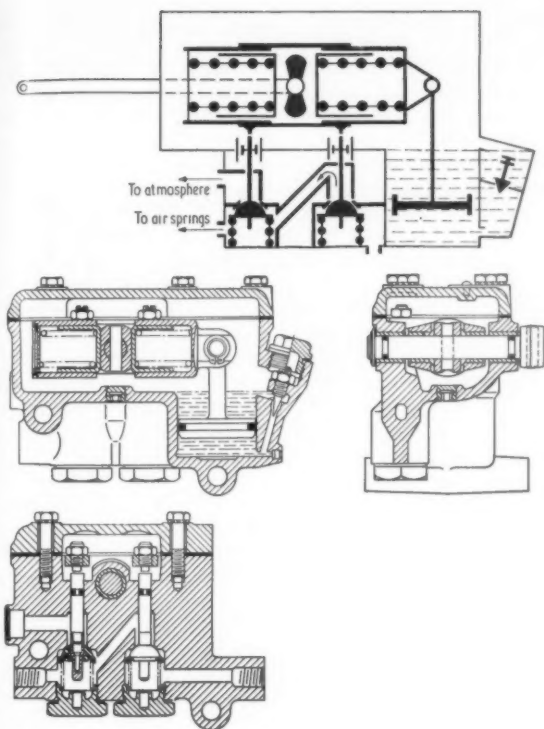
The Phoenix Gummiwerke, of Hamburg-Harburg, are producing under licence the Firestone air suspension systems. Development of air suspension has been carried out for many years by The Firestone and Rubber Co.: for example, a paper entitled "Air Springs—Tomorrow's Ride," by Roy W. Brown, of this Company was published in the 1936 issue of the *Journal of the Society of Automobile Engineers*.

Dunlop manufacture a damped, automatic levelling valve for use in conjunction with pneumatic suspension



These three illustrations, one on the left and two on the right, show pneumatic suspension layouts proposed by Dunlop. That on the left is, of course, of a rear suspension arrangement, while the other two are for a front axle, a similar method of location being employed in each case





Above: Diagrammatic illustration showing the Metzeler pneumatic spring applied to a wishbone type front suspension arrangement

Top, left: A diagram showing the principle of operation of the Knorr-Bremse, hydraulically-damped, automatic levelling valve

Bottom, left: Layout of the Knorr-Bremse height regulator valve. Spring-load plungers are interposed between the cam and rocker

An interesting detail described in that paper is the pendulum valve, which has been mentioned again recently in technical articles on air suspension published on the Continent. It is normally inserted between the pneumatic spring and the auxiliary tank. As can be seen from the accompanying illustration, it is a simple disc type valve, the disc being free to move vertically between two seats. When it moves on to the upper seat, it completely closes the passage between the spring and the reservoir: in other words, it acts as a non-return valve during upward movements of the suspension. Similarly, when it moves on to the lower seat, it again closes the main passage, but in this case, auxiliary passages formed by holes drilled round the periphery of the seat remain open. In these circumstances, that is on the rebound stroke of the suspension, the flow of air from the auxiliary tank to the main tank is restricted, so that the rate of pressure drop for a given rebound movement of the suspension during a short period of time is high.

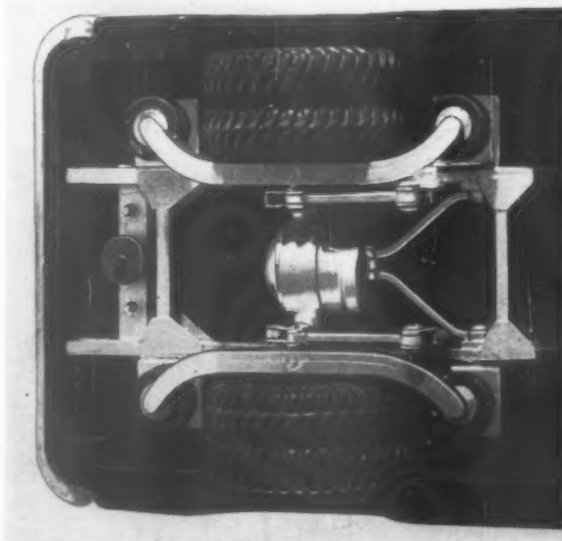
Normally, when the suspension is deflected upwards, a pendulum device prevents the valve from rising above its mid-position, thus holding it clear of the upper seat. In this mid-position of the valve, the flow of air between the spring and the auxiliary tank is least restricted. It follows that the spring rate during the bump stroke is lower than during the rebound stroke. When the vehicle is cornering, however, the pendulum, under the action of centrifugal force, swings to one side and allows the valve to come on to its upper seat during bump strokes. Thus, by isolating the spring from the auxiliary tank, it increases the spring rate and therefore improves the roll resistance. The valve can also be designed so that the pendulum releases the valve during acceleration or braking. This increases longitudinal stability; for example, it can be arranged to prevent nosing-down during braking.

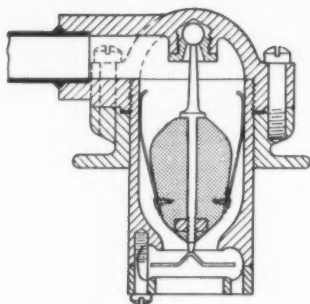
Despite the obvious advantages of this valve, it also has a number of disadvantages, which perhaps account for the fact that it has not so far been widely used. Nevertheless, there is probably a case for re-examining its potentialities in the light of the extensive development work currently in progress in connection with air suspension systems. The first point to be considered is whether the incorporation of

such a valve is, in fact, desirable: although it increases the roll stiffness when the non-return valve is closed, it at the same time increases the natural frequency and might possibly tend to give an uncomfortable ride. No doubt the answer to this question has been provided by development work that has already been carried out.

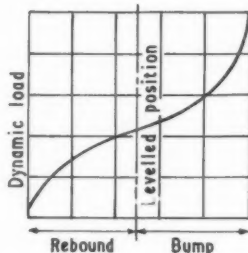
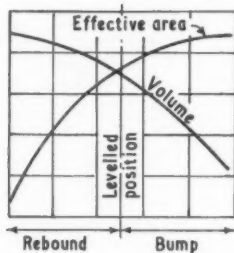
With a valve of this type incorporated in the passage between the air bellows and the reservoir, it would appear to be difficult to obtain an entirely free flow of air between the two components, should this be desired. It is possible, however, that the degree of obstruction might be limited sufficiently to avoid affecting adversely the suspension characteristics. Probably the key question, the answer to

Illustration of a display model, showing the general layout of a Dunlop rear suspension system for a conventional driven axle

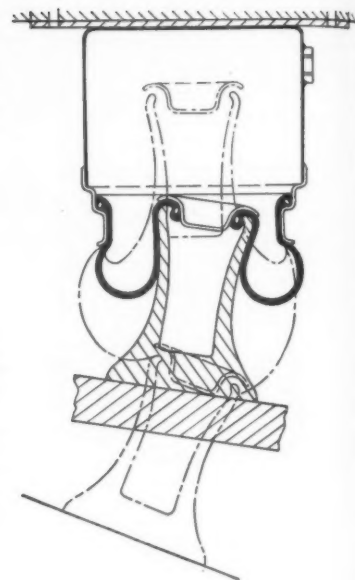




Firestone pendulum valve, which, under the influence of centrifugal force, allows a non-return valve to close the port between the pneumatic spring and auxiliary reservoir



A cast piston is shown in this illustration of the Firestone Airide spring. However, in practice, it is probable that a pressed steel piston would be used



Left: Effective area and volume characteristics, and the dynamic load curve of a typical Firestone spring

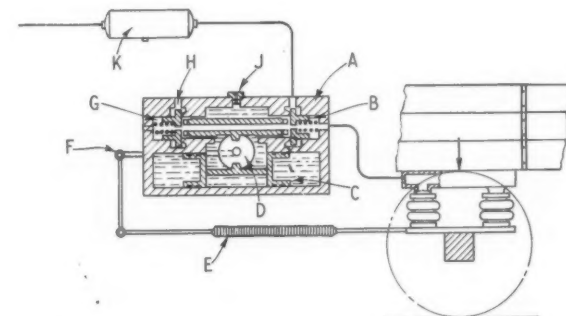
Below: The Westinghouse hydraulically-damped valve

A levelling valve assembly; B inlet valve; C damper piston assembly; D actuating drum; E spring element; F actuating arm; G exhaust valve; H exhaust port to atmosphere; J filler plug; K air reservoir

which decides if such a valve is to be used, is whether adequate roll stiffness can be obtained simply by the use of a single-convolution type bellows or a cylinder, piston and seal type spring arranged in such a way that their rates increase with deflection.

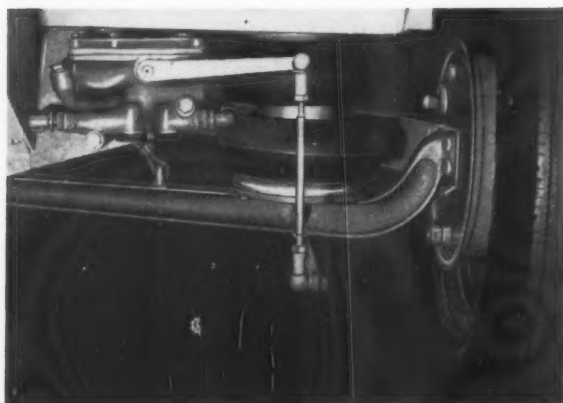
It should be noted that the effect of employing this type of valve differs from that obtained by the incorporation of an anti-roll bar. With an anti-roll bar, the effective spring rate is increased not only during cornering, but also when one wheel is deflected alone, instead of both simultaneously. On the other hand, the non-return valve comes into operation only during cornering and therefore the suspension rate remains appropriately low for all vertical deflections of the wheels when the vehicle is travelling in a straight line. Thus, the ride obtained with a system incorporating a non-return valve should be better than that with a suspension in which roll stiffness is obtained by the incorporation of an anti-roll bar.

The latest type of Firestone Airide spring and its typical performance curves are shown in accompanying illustrations. This spring is of the single-convolution type, or perhaps it might better be described as a cylinder and piston with a rolling diaphragm seal. The actual form of the cylinder and piston varies according to the application: for example, the



piston can be a pressing, and the cylinder can be formed by appropriately pressed parts of the vehicle structure. The piston shown in the illustration is of a shape designed to give a rate that increases rapidly towards the upper limit of the bump stroke and decreases rapidly towards the lower limit of the rebound stroke. Among the advantages of this type of spring, as compared with the double-convolution type, are that it is easier to install, it can be designed to give lower frequencies and better characteristics, and its overall height is relatively low so installation presents fewer difficulties.

A mock-up showing the Metzeler, hydraulically-damped, automatic height regulator valve, installed in conjunction with a pneumatic spring and a swing axle type front suspension arrangement



Westinghouse

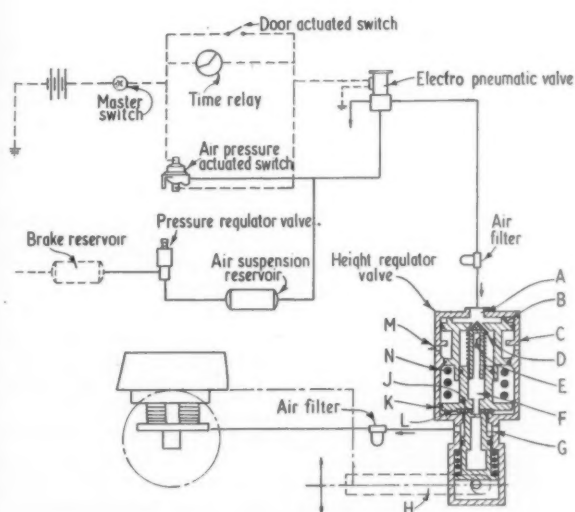
An interesting feature of the Westinghouse air suspension systems is that they can be employed in conjunction with a valve that automatically regulates the degree of braking obtained on the road wheels, according to the load carried. This valve is intended primarily for use with trailers and it has the following advantages. It enables the best possible relationship to be maintained between the braking force and the vehicle load, so that the stopping distance is minimized, while at the same time there is less risk of the wheels locking and the vehicle and trailer jack-knifing. The adjustment is made automatically, so there is no danger of accidents being caused, as there is with hand-operated systems, because the driver forgets to make the adjustment. Tyre wear is minimized because of the absence of wheel locking. It is also possible, by using these valves, to regulate the distribution of braking effort between the front and rear wheels, so that the maximum possible braking efficiency is obtained in reverse as well as in the forward direction. In other words, the arrangement, whereby perhaps 60 per cent

of the braking effort is effected at the front wheels and only 40 per cent on the rear, can be automatically reversed when the brakes stop the vehicle from running backwards.

The Westinghouse, hydraulically, damped, automatic height regulator valve for use in conjunction with pneumatic springs is shown diagrammatically in an accompanying illustration. Its actuating arm is connected to a drop link which, in turn, is connected to a flexible arm fixed to the unsprung portion of the suspension assembly. This flexible arm is formed by a close-wound coil spring.

In the body of the valve assembly, the valve-stem and double-acting damper piston assembly are horizontal, one directly above the other, with their axes parallel. Between the two is the actuating drum, which is mounted on a spindle rotated by the actuating arm. The axis about which this drum rotates is normal to the plane containing the axes of the valve stem and damper piston assembly. A tongue projecting radially from the valve-stem and another projecting from the damper piston assembly register in diametrically-opposite slots in the actuating drum: thus, the damper piston assembly and the valve-stem move simultaneously in opposite directions. An advantage of this horizontal valve and damper layout is that the actions of neither the valve nor the damper are affected by vertical accelerations experienced when the vehicle is operated over a rough terrain.

There are two valves housed in chambers one at each end of the hollow valve-stem. These valves are retained on their seats by compression springs interposed between them and the ends of the valve body. As can be seen from the diagram, connections are taken from the pneumatic spring and the air reservoir into the chamber at one end of the body, while the chamber at the other end has only an outlet port to atmosphere. When the load on the pneumatic spring is increased, the unsprung portion of the suspension assembly deflects upwards, relative to the sprung portion, and the link E moves with it. However, since this link is a close-wound coil spring, and the motion of the actuating arm and drop link is damped, it bends initially and then gradually straightens as the damper allows the valve stem to move to the right, towards the inlet valve at that end of the unit.



Above: Westinghouse electro-pneumatic control system and levelling valve suitable for application to buses for urban routes

A non-return valve; B pressure regulator valve; C trailer air reservoir; D air filter; E height regulator valve; F air filter; G actuating lever

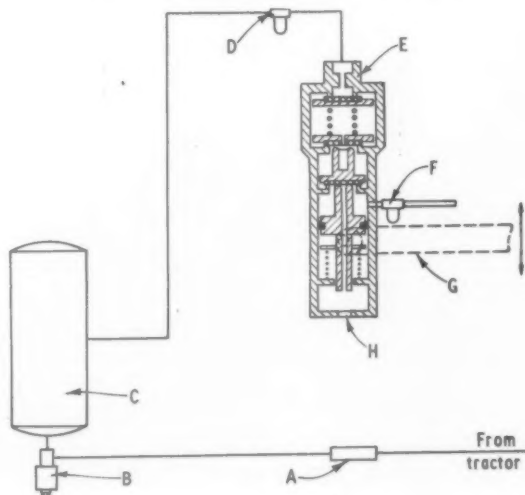
Right: A system, recommended by Westinghouse, for trailer suspension

After the delay period, the end of the stem comes up against the inlet valve and lifts it off its seat. This allows air from the reservoir to pass into an annular chamber round the valve-stem and thence through radial holes into the stem. From there, the air passes through an axial hole in the centre of the inlet valve into the chamber to the right, and thence into the pneumatic spring. When the spring has extended sufficiently to restore the suspension to its normal position, the valve-stem is centralized and the valve is again seated.

If the load in the vehicle is decreased, so that the spring height becomes too great, the valve-stem is moved in a similar manner, but to the left. This unseats the exhaust valve, which is that on the left-hand side, and allows air to pass out from the pneumatic spring, through the hole in the centre of the right-hand valve, along the bore of the hollow valve-stem, out through the radial holes at the left-hand end of this stem and thence through the port to atmosphere. The axial hole in the centre of the left-hand valve is incorporated to ensure that the pressures on each side of it are at all times balanced. If the hole were not there, this valve would be blown off its seat when the stem is moved to the right and the valve at the other end unseated.

Some economy of air consumption is obtained with the Westinghouse electro-pneumatic control for regulating air suspension systems on buses, as shown in an accompanying illustration, despite the fact that it is not hydraulically damped. The operation of this Westinghouse control is based on the fact that the load on the vehicle can only be varied when the doors are open.

An electro-pneumatic valve has been interposed between the air reservoir and the automatic height regulator valve. There are three electric circuits, all in parallel, to actuate this electro-pneumatic valve. One is made only when the doors are opened. The second is a time-relay, which causes the valve to open for 10 seconds every 3 minutes, so that compensation can be made for the changes in temperature and for leakage from the pneumatic system. Finally, the third circuit is through a switch actuated by a diaphragm subject to the pressure in the air supply system. When this pressure is less than 4 atmospheres, the circuit is closed, so that air can pass continuously from the compressor, through the reservoir and the height regulator valve, into the pneumatic springs. This circuit is incorporated so that if the pressure in the reservoir is too low when the vehicle leaves the depot at the beginning of its run the air is supplied continuously from the compressor, through the brake reservoir and then the air suspension reservoir, to build up the pressure in the pneumatic springs; otherwise the build-up could take place only during the periods of 10 sec when the valve is opened by the time-relay section of the circuit.



The arrangement of the pneumatic circuit recommended by Westinghouse is as follows. Air is taken from the reservoir for the brake system, through a pressure reduction valve, set to pass the air on at a pressure of about 4.2 atmospheres to the reservoir for the pneumatic suspension. The outlet from this reservoir goes to a T-junction, one arm of which is connected to the pressure-actuated switch of the electrical circuit and the other to the electro-pneumatic valve. From the electro-pneumatic valve, the air passes through a filter to the height regulator valve and thence through another filter to the pneumatic springs.

It appears that damping is effected solely by restriction of the air passages in the height regulator valve. The method of operation of this valve can be seen from the accompanying diagram. Air enters the chamber A, forcing the piston B down on to its stop C. At the same time, the air can go past the non-return valve D, through the small holes E into the chamber F. If the position of the actuating lever H is such that valve G is clear of the seat J, the air goes from the chamber F, past the valve G into the pipeline to the pneumatic springs. On the other hand, if the position of the lever is such that the valve G has been lifted, the air in chamber F can go no further; in fact, the valve K is lifted off its seat L, so that air can be exhausted from the pneumatic springs, past the periphery of the valve K and the lower flange of the piston B, and through the exhaust ports to atmosphere.

In the diagram, the piston B is shown in its uppermost position, in which its lower flange seals off the passage to atmosphere. It is held in this position by the spring N when the pressure of the air supplied from the reservoir is low. In these circumstances, the compression in the spring that retains the non-return valve on its seat is light so that it offers a minimum of opposition to the passage of air into the chamber F.

Westinghouse manufacture a different type of height regulator valve for trailers. As can be seen from the accompanying illustration, air is taken from the pneumatic system

on the tractor, through a non-return valve mounted on the trailer, to a pressure regulator valve, and thence into a reservoir. The outlet from the reservoir goes to an air filter and then through the height regulator valve and another air filter to the pneumatic suspension springs of the towed vehicle.

In the height regulator valve, the air first enters a cylindrical chamber that has two ports, one at its upper and one at its lower end. These ports are closed by two plate-valves with a compression spring interposed between them to force them on to their seats. The upper of these two valves, which seats on the inlet port, acts simply as a non-return valve, while the lower one is actuated by the upward-projecting stem of a third valve, housed in a chamber below it. This third valve, in turn, is actuated by a hollow push rod, which is moved up and down by the lever connected to the unsprung portion of the suspension assembly. When this push rod is lifted, its upper end seats on the lower of the three valves, which it then lifts, pushing the intermediate valve up off its seat. This allows air to flow from the upper chamber into the lower one, and thence through an outlet to the pneumatic springs. As the spring extends, the actuating lever lowers the hollow push rod until the inlet valves are closed. Further downward movement of this hollow rod lowers its upper end from its seat and allows air to flow back from the pneumatic springs, through its bore to atmosphere.

Miscellaneous

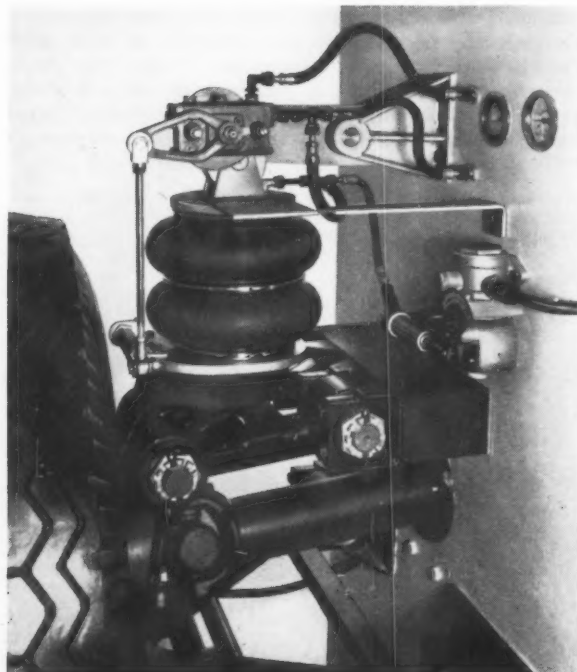
Some interesting development work has been carried out with rail cars on which refrigerant gas, such as ammonia, is used instead of air, in bellows type springs. This system, which has been described in the September 1956 issue of *Eisenbahn Technische Rundschau*, has a number of advantages, as compared with the more commonly employed systems, in which air is used as the springing medium. First, it is a closed system, the spring height being regulated by varying the temperature of the refrigerant vapour, and therefore a compressor is not needed. It would appear that the temperature can be controlled either by employing an electrical heating device or by using a heat exchanger, through which exhaust gas from the engine is passed. With the latter arrangement, the heat exchanger would have to be installed in parallel with the normal exhaust system and the flow through it regulated by a valve, probably of the butterfly type.

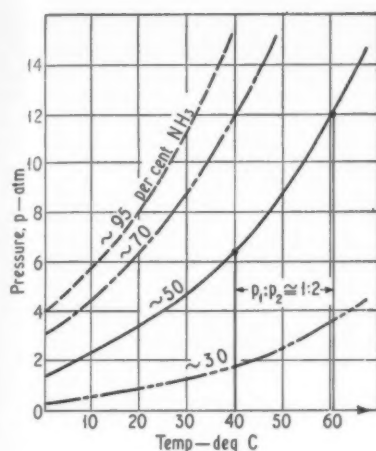
The reason for using refrigerant gas instead of air for this thermally-regulated system is that it reduces the energy input required to adjust the height of the spring. That the reduction is considerable can be seen from the following example. In a spring about 20 cm diameter \times 25 cm long, and with a rate of 100 kg/cm, the normal working temperature is about 30 deg C. If its static load is increased from 3 tons to 6 tons, and the deflection is to remain unchanged, an electrical energy of about 108,000 W-min must be supplied to raise the temperature of the air in the spring, and thus increase its volume the appropriate amount. On the other hand, if ammonia gas is substituted for the air, only about 8,800 W-min is required.

As is well known, ammonia gas has a very strong tendency to dissolve in moisture. Moreover, its properties vary considerably with the moisture content. From the accompanying curves, it can be seen that a rise in temperature of only about 20 deg C is necessary to double the pressure and therefore the load-carrying capacity. There are, of course, other refrigerant gases, the properties of which might be investigated.

Development work has been carried out by Waggonfabrik Uerdingen, in Germany, on a railcar equipped with gas-filled springs. Because of the relatively high temperatures that are liable to be attained in this kind of spring, metal bellows

A mock-up of the Westinghouse air suspension system, with a trailer brake pressure regulator valve on the right. Where it is practicable to mount the pneumatic spring directly over the king pin, the loads on the suspension links and their bearings are greatly reduced





Variation of pressure with temperature of various percentages of ammonia gas in water

and rebound conditions is not so great as it otherwise would be.

When the subject of air suspension is raised, the question invariably arises as to whether a hydro-pneumatic system, such as that employed on some of the Citroën cars, should be used. In this system, a jack containing an inert gas, separated from the hydraulic fluid by a rubber diaphragm, is employed as the springing medium. This gas is sealed in its container at the closed upper end of the jack, and adjustment for height regulation is effected simply by varying the volume of hydraulic fluid between the rubber diaphragm and the piston at the lower end of the jack. Thus, the column of hydraulic fluid acts simply as a strut, the length of which can be adjusted to regulate the static deflection.

It is, of course, generally undesirable to install both a hydraulic and a pneumatic pump; therefore, for commercial vehicles that are already equipped with an air compressor, the pneumatic spring is the obvious choice. However, where space is restricted, hydraulic actuation of the various components is in many instances preferred. Nevertheless, the pneumatic system has the advantage that its natural frequency does not vary so greatly with load as does that of the hydro-pneumatic system just described. Also, hydraulics generally involve sliding valves, and the system therefore has to be kept scrupulously clean.

Pneumatic systems, on the other hand, can be arranged in such a way that poppet valves with flexible seats can be used, and therefore extreme cleanliness is not of such vital importance. Sealing does not present so many problems in pneumatic systems and there need be no sliding pistons or other components liable to wear by abrasion. On the other hand, difficulties are liable to be experienced if precautions are not taken to prevent temporary failures due to the freezing of condensation round the valves and in the pipelines. To avoid these difficulties, some manufacturers simply incorporate a water and oil trap, while others introduce methyl-alcohol vapour into the system, to lower the freezing point of the condensed water vapour that inevitably is there.

were employed and they were covered with jackets of thermal insulation material. A disadvantage of this arrangement is, of course, the danger of fatigue failures of the bellows and possibly failures due to the corrosive effects of the gas employed. For road vehicle operation, there would also be some problems to be solved with regard to initial warming up immediately after starting from cold. Perhaps the corrosion and fatigue problems could be solved by the use of heat-resistant materials, such as silicone rubbers.

The development work confirmed that the spring rate obtained with this gas is lower than that which would be obtained with air. This is because, when the bellows extend, and the temperature of the gas is therefore lowered, some of the gas tends to condense into fluid droplets, thus releasing latent heat of vaporization; then, when the spring is compressed again, these droplets evaporate and absorb latent heat of vaporization. As a result of these alternate changes in state, the range of temperature variation between bump

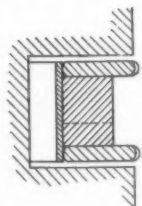
HEPOCROM OIL CONTROL RING

IN view of the success of chromium plating in reducing compression ring and cylinder bore wear, Hepworth and Grandage Ltd., of St. John's Works, Bradford 4, have developed the Hepocrom chromium plated oil control ring. This ring comprises four components, namely a spring expander ring, and an upper and a lower rail separated by a

cast iron spacer. The outer faces of the two rails, where they bear on the cylinder bore, are heavily plated with high quality chromium. These rails are supported over their full radial depth by the cast iron spacer, which is accurately ground to control the working clearance of the ring in its groove. This prevents the rails from rocking, which otherwise might lead to oil pumping.

Oil scraped off the bore into the space between the rails drains through the large opening at the gap, and also through grooves machined radially in the end faces of the cast iron spacer and passes away through holes drilled in the base of the ring groove to the sump. Since there are no spring rail-spacers, side drag in the groove is avoided and radial pressure between the rails and the bore is accurately controlled. Moreover, free movement of the ring in its groove enables it to follow readily the contours of a worn or oval bore, despite piston rock. Because of the moderate pressure of the ring on the cylinder wall and on the sides of its grooves, as well as the inherently low friction of the chromium plated bearing surfaces, reduction of mechanical efficiency owing to ring drag is minimized. These characteristics also lead to a low rate of bore wear.

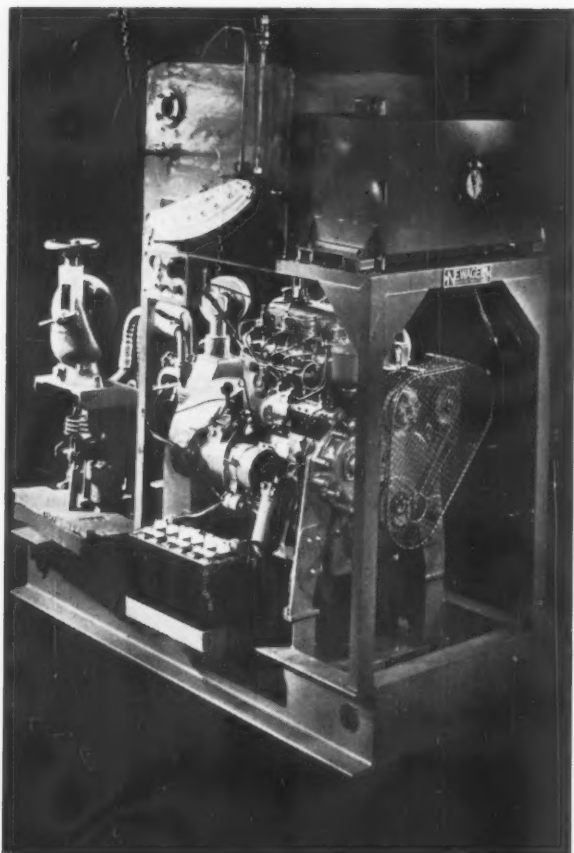
The ring is designed in such a way that it cannot be fitted wrongly, provided the piston groove is the correct width and radial depth. There are no tapers, angles or special joints requiring attention, and no adjustments to make.



Cross section through a Hepocrom oil control ring, which comprises a spring expander ring and two rails separated by a cast iron spacer

The oil drainage groove in the end faces of the cast iron spacer ring can be seen in this view





Engine Testing

Specially Designed Equipment for Technical

Colleges and Training Establishments

Newage test equipment with 2.2 litre, high speed diesel engine. This equipment is designed as a unit, and incorporates all the necessary instrumentation for a wide range of tests

IN any heat engines laboratory, an essential item of equipment is an internal combustion engine incorporating a dynamometer and other testing and measuring apparatus. The importance of such a unit has, in recent years, been greatly increased by the development of high speed, high efficiency engines. Only when students are instructed in the design features and characteristics of such engines, is it possible to ensure that their laboratory experience can later be usefully related to practice.

In the past it has been fairly common practice, particularly in the case of smaller engines, for college and other authorities to acquire the necessary equipment over a period of time, beginning probably with only an engine and dynamometer, then adding ancillary items when they proved indispensable. This procedure has obvious disadvantages. A test unit should be specifically designed for its purpose, thus ensuring that all components are correctly correlated and integrated to give maximum accessibility and adequate facilities for the performance of the various tests.

To help meet the need for thoroughly trained automobile engineers, Newage (Manchester) Ltd., 6 Carlos Place, Grosvenor Square, London, W.1 have developed a range of engine testing equipment. A typical installation is shown in the accompanying illustration. The standard equipment comprises an internal combustion engine, a dynamometer, indicator, air tank and fuel consumption meter, all combined into a single unit and conveniently mounted on a common baseplate. From the wide range of tests that can be carried out with this equipment it is possible to calculate efficiency at variable load, heat balance, torque, fuel consumption, etc.

Naturally, the most important item in the unit is the engine. It can be selected from the wide range of engines produced by the British Motor Corporation, and can be either a petrol

or a diesel unit. For convenience and economy, the petrol engine usually selected is the 1,500 cm³ model. Diesel units can be based on any one of the three Newage/B.M.C. diesel engines. The illustration shows a unit with a 2.2 litre diesel engine. The equipment associated with the petrol engine can be varied to suit individual needs.

Ignition. This can be either magneto or distributor. The latter is available with manually-operated advance and retard in addition to normal automatic mechanism. A scale and pointer are provided to facilitate readings of ignition settings relative to optimum position. The ignition system is suppressed to comply with statutory regulations.

Carburettor. Usually an updraught carburettor, with manually-operated continuously variable main jet, is supplied. Alternatively, a downdraught pattern can be fitted.

Cooling. This can be effected by header tank fed from the water main, or alternatively, and generally the more satisfactory method, by means of a separate water cooler and water circulating pump.

Starting. Electric starting is employed, with a 12 volt battery. For this type of set, the standard charging dynamo is usually omitted and a wall-mounted trickle charger introduced.

Silencing. Normally the system comprises an exhaust pipe and cylindrical silencer, but for applications where noise cannot be tolerated twin acoustic silencers can be fitted. They are usually located in a duct in the laboratory floor.

Coupling. All engines can have a small shaft extension on the end of the crankshaft to facilitate adaptation of a direct coupling drive to the indicator.

The dynamometer shown in the illustration is a Heenan and Froude hydraulic type, model DPX.2. It is mounted, together with the engine, on a rigid fabricated baseplate.

Normally, the drive between the engine and the dynamometer is by means of a cardan shaft, but where space is limited, a flexible coupling replaces the cardan shaft. Careful alignment and the provision of machined support pads on the baseplate ensure that no external loads are imposed on the dynamometer shaft and bearings. As in the case of the engine, the dynamometer may be cooled by mains water or, preferably, by means of water circulated from a separate cooler.

The indicator is bolted and dowelled in position on the baseplate. It is driven directly from the engine through a vernier flexible coupling. This permits easy removal of the indicator for use elsewhere, and also provides maximum accessibility during normal operation with the engine. Dobbie and McInnes "Farnboro" type indicators are normally used, but alternative types can be fitted when required.

Provision is made to ensure that the engine T.D.C. position can easily be found and marked on the diagram sheet, together with calibration lines at any desired pressure reading. Light pressure work is facilitated by a low pressure unit which, when required, is attached to the standard indicator on the side opposite to that occupied by the normal pressure equipment. The electronic relay unit is mounted below the fuel tank in a position conveniently adjacent to the indicator. It can easily be removed for routine inspection.

Compressed air for use with the indicator is stored in a compact pressure cylinder mounted alongside the base. Under normal conditions the cylinder has sufficient capacity to produce 50 diagrams. For light pressure work, an electric motor driven pump is available. This provides the necessary low pressure air and, when required, also operates a vacuum pump.

Generally the indicator is arranged for use with only one cylinder of the engine. However, when required it can be connected to all cylinders, the pressure pipes being routed through a distribution block, an arrangement that facilitates the change-over from high pressure to low pressure work. A multi-way switch enables the impulse from any selected

cylinder to be passed to the relay unit. The pick-up units are usually mounted to the cylinder head by means of a water-cooled adaptor that screws into the cylinder head in the position normally occupied by the spark plug, which is re-positioned in the side of the adaptor. Although this method of adapting the pick-up unit necessitates re-positioning the spark plug, it does not, in practice, introduce any undesirable effects.

For air consumption measurement the inlet air is taken through a calibrated orifice plate into an air box before passing to the engine. This air box is of sufficient size adequately to damp undesirable pulsations. It is covered with a coating of flexible material to reduce noise to an acceptably low level. Air flow measurements are taken direct from a Kent curved tube manometer, which is usually mounted on a wall or placed on a stand near the engine unit. Alternatively, where it is desired that experiments be carried out on the actual measurement of air flow, a U-tube can be fitted to the side of the box. As the U-tube involves considerable calculation to obtain the air flow figures, it is only supplied when specifically ordered.

An Amal flow meter is used for fuel consumption on a petrol-engined unit. It provides instantaneous and accurate figures for fuel consumption at any speed or load. A diesel unit is supplied with a glass cylinder with markings to indicate 0.5 and 0.25 pints. This, in conjunction with a stop watch, provides a simple means of computing fuel flow. Fuel cocks are provided to allow a continuous series of fuel tests to be carried out without stopping the engine.

All normal engine instruments and controls are provided. These, including a variable speed cable, are conveniently grouped on an instrument panel. Special care has been taken to reduce vibration and noise to a low level. All fuel lines incorporate flexible inserts, and the fuel tank is flexibly mounted on the supporting framework. To assist students in the operation of the engine and ancillary equipment, labels giving the basic operating instructions are permanently attached to the unit at the appropriate points.

Star Tolerance Rings

AS can be seen from the accompanying illustration, a Star tolerance ring consists of a spring steel strip containing a number of corrugations. Each corrugation acts as a spring, and when compressed between two machine parts exerts a constant load dependent upon the degree of compression. The straight ribbon on either side of the corrugations prevents the pitch of the corrugations from changing on assembly; the shape of each corrugation merely alters.

The radial space between the mating metal components into which the tolerance ring is to be fitted is so determined as to compress the corrugations, with the result that a pre-determined degree of torque can be transmitted. To transmit greater or lesser torque is simply a matter of adjusting the width of the tolerance ring.

There is a wide range of applications for which Star tolerance rings provide many technical and economic advantages:

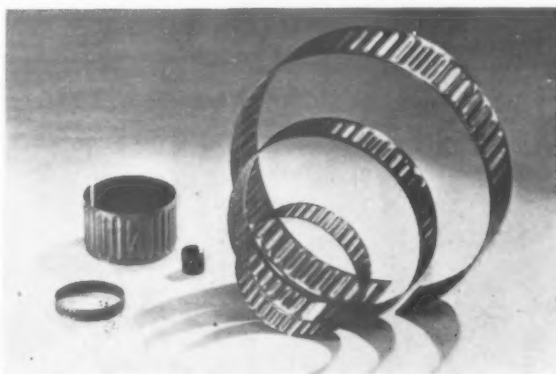
- (a) They provide an interference fit with wider limits on both machine parts.
- (b) They transmit a given amount of torque.
- (c) They compensate for heat or work expansion.
- (d) They compensate for variations in machining tolerances and automatically adjust for a degree of misalignment.

In addition to allowing wider machining tolerances on mating parts that must be an interference fit, Star tolerance rings can also be used to advantage in some simpler applications, such as the fitment of hand wheels and lever knobs which are normally fitted by screw threads. The cutting

of screw threads can be completely eliminated, and the components can be securely held by the press fit afforded by the tolerance ring.

A further advantage is the ability to take up differential linear co-efficients of expansion of different metals, such as in the case of a ball bearing fitted in a light alloy housing. Star tolerance rings have been used on the Continent for years in many branches of engineering. They are now available in Great Britain from George Angus and Company Limited, Oil Seal Division, Coast Road, Wallsend-on-Tyne.

Typical Star tolerance rings



New Plant and Tools

Recent Developments in Production Equipment

THREE standardized, interchangeable head units, for boring, grinding and measuring respectively, are available for the optical co-ordinate machine recently introduced by the German firm of Friedrich Deckel. Thus, where full utilization is assured, the use of a single attachment provides an efficient single-purpose machine. Conversely, the range of attachments converts it into a general-purpose machine adaptable to a wide variety of work.

In general construction the machine has a rigid box-type base and the movable units, the co-ordinate worktable and gearbox, are adjustable in guide ways by means of push-button controlled, rapid traverse motors and manually operated fine setting controls. Settings for the worktable over an area of 15.7 in \times 10 in, are easily and directly read from screens with co-ordinate measuring reticule, providing an accuracy of adjustment to 0.00012 in. The gearbox is arranged for vertical movement and carries a bracket to receive the head attachments. This bracket is designed to compensate automatically for the effects of thermal expansion. All controls are within easy reach of the operator and the electrical equipment is housed in a separate cabinet.

Boring machine LKB. The boring head is a standardized unit that is already proved as an attachment for the tool milling machine manufactured by the Company. It can be tilted through 90 deg and has a range of twenty spindle speeds from 40 to 3,150 rev/min. The maximum height of work that, as standard, can be accommodated is 19.9 in, but this figure can be increased to 24 in by means of a raising unit. Spindle travel, with both manual and power operation, is 3.94 in.

There are six different feed rates from 0.0004 to 0.005 in/rev, and all can be used with any of the available spindle

speeds. Capacity is drilling up to 0.59 in diameter and boring up to 6.9 in diameter. The area of the worktable is 25.6 in \times 11.8 in. A full range of accessory equipment, including a universal facing and boring chuck in two sizes, is available.

Grinding machine LKS. A high-precision grinding head, which can be tilted 45 deg to either side of the vertical, enables grinding operations to be performed to extremely close limits. The range of applications includes cylindrical and tapered, internal and external surfaces; straight, angular, and segmentally shaped grooves; and the form grinding of profiles composed of radii and tangents. Stepless variation of spindle speeds—15,000 to 30,000 rev/min for wheels up to 22 mm diameter and 30,000 to 60,000 rev/min for wheels up to 15 mm diameter—is by a motor-driven frequency changer housed in the separate switch cabinet.

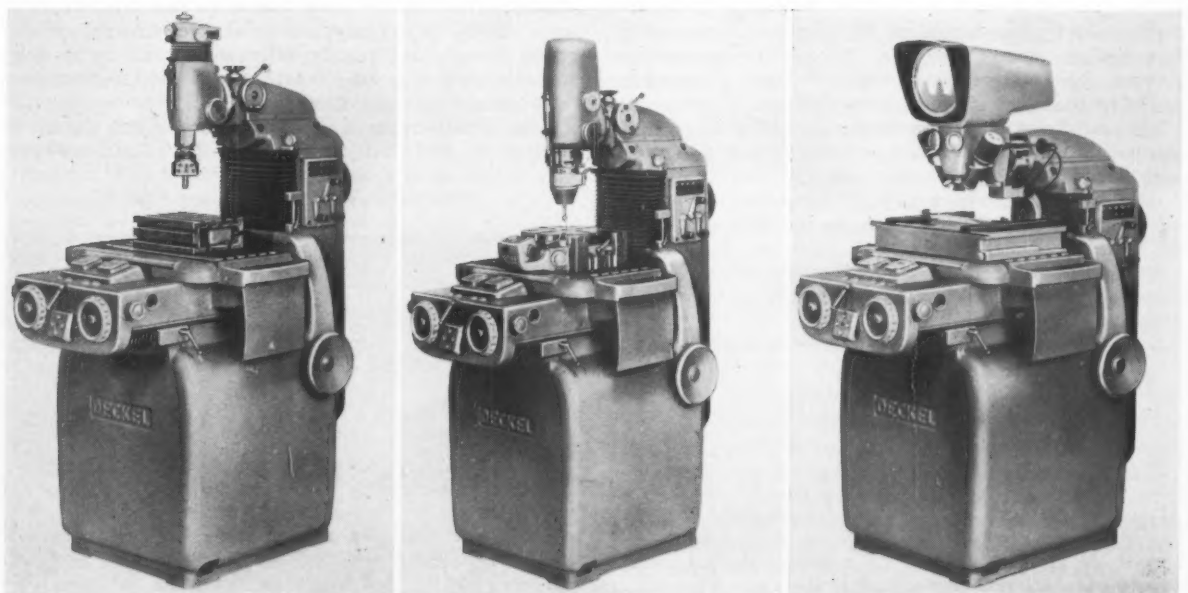
Spindle travel is from 0.156 in to 3.15 in and the oscillating vertical movement has three feed rates, 0.12, 0.24, and 0.48 in/rev. The number and progression of the spindle planetary speeds are 12 and 1.25, giving speeds from 40 to 500 rev/min. Minimum and maximum diameters of bores that can be ground are 0.031 in and 4.9 in.

A 12 in diameter circular table with optical adjustment of polar co-ordinates is shown on the grinding machine illustrated. It can be used either horizontally or vertically and readings down to 1 sec of arc are taken on a square screen. Indexing accuracy is 5 sec of arc.

Measuring machine LKM. Fitted with the measuring projector and used in combination with a variety of attachments and accessories, the machine can measure and check contours, the shape and pitch of screw threads, the accuracy of form tools, templates and the like. The magnification of

Three versions of the Deckel optical co-ordinate machine. Interchangeable heads can individually provide single-purpose boring, grinding, or measuring machines or, in combination, a general-purpose machine

Burton, Griffiths and Co. Ltd.



×10 or of ×20 diameters is fixed and remains constant. A vertical travel of 3.15 in is provided for the measuring head, which can be tilted 15 deg on each direction about the vertical optical axis. The diameter of the projection screen is 7.9 in.

Deckel machines are factored by Burton, Griffiths and Co. Ltd., Mackadown Lane, Kitts Green, Birmingham, 33.

"Multisize" collets

Substantial economies in production equipment can be achieved by the use of these new precision collets, it is



Each "Multisize" precision collet has an operational range over 0.125 in on diameter

F. Burnerd and Co. Ltd.

claimed. Each collet has dimensional flexibility to the extent of 0.125 in on diameter and a range of eleven units, already available, can handle work diameters from 0.125 in to 1.5 in. Other ranges will be introduced in the near future by the manufacturers, F. Burnerd and Co. Ltd., 5 Balfour Place, Park Lane, London, W.1.

"Multisize" collets ensure exceptional accuracy in centring and a grip many times greater than the conventional spring collet. The grip is provided by the action of accurately ground, wedge-shaped blades radially spaced in the tapered body of the collet. Depending upon the size of the collet, six or eight blades are fitted. The unit is not subject to deformation since the blades are free to slide within the slots in the body and thus to accommodate the diameter of the bar stock. When closed, the gripping action of the blades is exerted parallel to the bar over their entire length. It is this movement that gives the collet its exceptional accuracy. Deep cuts can be taken on work without risk of slip or chatter. Accuracy in machining is claimed to be within 0.0005 in at a distance of four inches from the nose of the collet.

Using conventional equipment, from 16 to 20 collets may be required to handle all diameters, including metric sizes, from 0.125 in to 0.25 in since deviation in excess of, say, 0.004 in leads to uneven grip. A single "Multisize" collet can thus replace a considerable number of standard collets.

A collet chuck, illustrated on the Contents page, has been designed specifically for use with the new collets. It can be supplied with a flange for attachment to an adaptor plate or for direct mounting on various standard spindle noses. A feature of the chuck is a ball thrust race which virtually eliminates operational friction. Time to change from one collet to another is no longer than with ordinary equipment.

Accurate length positioning of short-length components, as for second operation work, is arranged by means of an

adjustable end-stop. It is readily fitted or removed as it is a push fit in the chuck body. Ball detents engaging in a recess machined in the body locate the stop in position and a central screw provides adjustment.

Erodosharp Mark II

The first Erodosharp machines for re-servicing carbide tools were introduced by Wickman Ltd., Banner Lane, Tile Hill, Coventry, about six years ago. Since then many of these machines have been in continual use for single-point tool dressing with eminently satisfactory results. The Erodosharp Mark II, a development of the earlier machine, embodies two major refinements in design, based upon the experience gained. Two revolving electrodes and adjustable tool rests are now provided, and an extractor fan is built into the machine base to enable fumes produced during processing to be ducted to atmosphere independently of other extractor systems.

In appearance it resembles a conventional grinding machine, except that two revolving iron electrodes replace the usual abrasive wheels. Metal particles are removed from the tool by the effects of a controlled electrical discharge between electrode and tool across a dielectric gap, which is a thin film of oil on the revolving electrode. Since there is no physical contact between electrode and tool, there is no load on the wheel, no wear due to abrasion, and no heat generated in the tool. This means that the tip and shank of carbide tools can be dressed simultaneously without any risk of the tip cracking from thermal shock. The conventional method of using different grinding wheels for roughing and finishing is eliminated. Finish is selected simply by operation of a three-position switch, which gives different cutting rates for roughing, normal stock removal, and finishing.

The actual tool dressing process is performed in the same way as on grinding machines, except that no pressure is required, and re-servicing times are closely comparable with those of conventional methods. Tools dressed by the Erodosharp process have been found to have a serviceable life

The Wickman Erodosharp Mark II machine for re-servicing carbide-tipped tools

Wickman Ltd.



as long as tools ground by conventional methods, and in some cases much longer. This is because the finish on Erodo-sharpened tools consists of minute saucer-shaped depressions which resist abrasion better than the minute ragged indentations left by ordinary grinding. Wheel life is almost indefinite, as the slight pitting resulting from prolonged use can easily be smoothed off with an abrasive stick.

The largest single economy offered by this method is the direct and immediate saving in diamond wheel costs. Except for the lapping of superfine cutting edges, the Erodo-sharp will produce all the results achieved with diamond wheels.

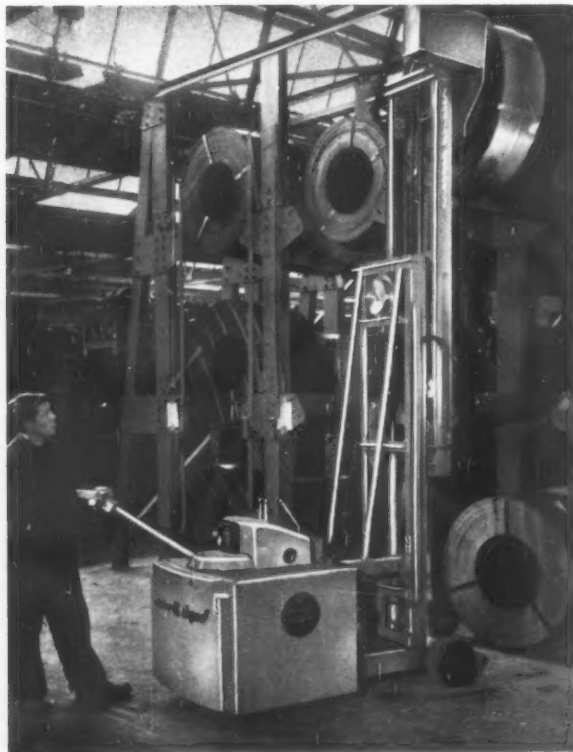
Precision micro-drilling machine

Accurate chucking and the maintenance of drill concentricity are prime considerations in the successful drilling of holes in the micro-drill range. The Dumore Co. of Racine, Wisconsin, U.S.A. has recently developed a versatile, sensitive-feed, micro-drilling machine with an accurately centring magnetic chuck. A drill is mounted in an appropriately sized collet and can then be inserted in the magnetic chuck and centred without the need to stop the spindle rotation, thus facilitating a rapid changeover when drilling successive holes of different sizes.

The worktable, drilled and tapped for the attachment of fixtures, is provided with longitudinal and transverse movements up to 1.125 in. Control is by conveniently positioned knobs and the extent of movement is indicated on large-diameter Ames dial gauges, permitting rapid location and precise spacing of holes. A weight, adjustable on a lever arm, counterbalances the weight of the table and fixture to permit sensitive feed of the table by means of a large control knob. Table feed is limited by a calibrated micrometer positive stop and it is possible to maintain a tolerance of 0.0005 in on the depth of holes drilled.

Voltage control by means of an adjustable transformer

Lift-truck adapted for coil handling
Lansing Bagnall Ltd.



Sensitive feed micro-drilling machine
Dumore Co.

is used to vary the motor speed from 2,000 to 17,000 rev/min. While operating, the progress of the drill can be watched by the aid of a mounted $\times 10$ power magnifier focused on the hole.

Handling and storing coiled steel strip

Even where relatively small quantities only are involved, the storage and handling of strip steel in coils is likely to present problems. The stock should be readily accessible, it should not be liable to sustain mechanical damage, and there should be no "dead ends" in the storage area where coils may remain for long periods and possibly suffer deterioration.

Lansing Bagnall Ltd., of Basingstoke, made an extensive study of the problems for a large production plant and designed and developed a racking system and also a special coil-handling head attachment for a lift truck of their manufacture. This attachment, replacing the usual fork members, consists of a large vertical face plate from which projects at right angles a hollow spigot or core. The outer diameter of the core is slightly less than the inner diameter of the smallest coil of steel to be handled. On the underside of this core is a segment, subtending an angle of about 60 deg, which is displaceable vertically downwards on guide rails mounted on the face plate. When the core has been entered into a coil of steel, the segment is hydraulically operated and brought into engagement with the lower run of the inner diameter of the coil. Thereafter, the coil is securely held by hydraulic pressure until the operator has transported the load and positioned it, when he releases the segment and disengages the core.

The three-tier racking structure comprises eleven rows of columns defining ten passages or channels. On each side of a channel the columns are bracketed to carry, at two levels, inclined racks to receive the coils. At floor level, guide rails serve to align and locate a third row of coils. The truck can traverse the entire length of each channel and deposit or withdraw coils from any of the three storage levels.

Although the racking structure occupies a stores area of only 1,600 ft², it has sufficient capacity to hold more than 400 tons of steel strip in stock and readily available.

PLASTIC-COATED STEEL

New Material by John Summers & Sons Ltd. can be Bent, Formed, Drawn, Seamed and Welded

A REMARKABLE new coated sheet steel, termed "Stelvetite", has recently been introduced. Developed by John Summers and Sons Ltd., of Shotton, Chester, in collaboration with B.X. Plastics Ltd., it is a strip-mill, cold-reduced steel with a specially formulated Velbex P.V.C. coating. The reverse side of the sheet has either a Bonderized surface or an electro-zinc coating.

Stelvetite is produced on a continuous strip mill in a new plant and is at present available in all gauges from 26 B.G. to 16 B.G. (0.0196 in to 0.0625 in). Sheet width is in various dimensions up to 48 in and sheets are supplied in lengths up to 144 in. The thickness of the P.V.C. coating is 0.014 in. This figure was adopted as the optimum dimension after an exhaustive investigation of all foreseeable requirements and of the practical economic aspects. The standard coating thickness gives adequate protection from atmospheric corrosion, electrical insulation up to 4,000 volts, within wide limits is resistant to acids and alkalis, and is resistant to oils and greases.

Other features are good resistance to abrasion, stability at temperatures higher than those normally associated with P.V.C. alone, and it will not support combustion. It is warm and pleasant to the touch and can be washed and cleaned with soap or most detergents. Small quantities are available in one of four standard colours—white, green-grey, primrose or scarlet—but for larger quantities from minima of 10 tons in 26 B.G. to 30 tons in 16 B.G. sheet, any of the colours available for P.V.C. material can be supplied. The standard surface finish is a neat embossing, termed "Seal" as it simulates the surface of pin-seal leather. At present only a limited range of other embossings is available but either a smooth finish or a hide finish can be supplied if ordered in substantial quantities.

The outstanding property of Stelvetite is that it can be worked and treated in production as ordinary sheet steel without damaging the coating. Using ordinary tools it can be formed or bent with the coating either internal or external. It can be drawn in the usual dies and a test cup $5\frac{1}{2}$ in diameter

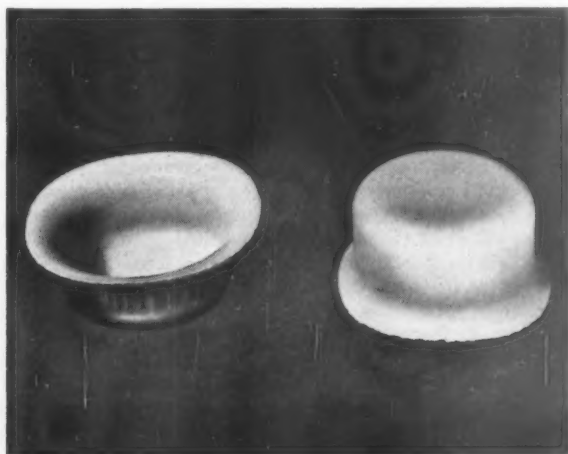
has been drawn to $3\frac{1}{2}$ in deep with a completely unimpaired external coating. In this connection it is reported that pressing or drawing operations are actually facilitated by the P.V.C. coating, which possesses a certain resilience and also exercises what may be termed a dry lubricating function. As will be seen in the illustration of the test cups, both produced with the standard press tools, the one with the coating inside exhibits draw markings on the external steel surface while on the other the external coating, which is "seal" embossed, is unblemished.

As an example of the tenacity of the bond between the P.V.C. coating and the sheet steel, the illustration of the "expanded" panel is included. In this the material is pierced at a close pitching, pressed out, and then bent by stretching, but in no instance is there any evidence of lifting or detachment of the coating.

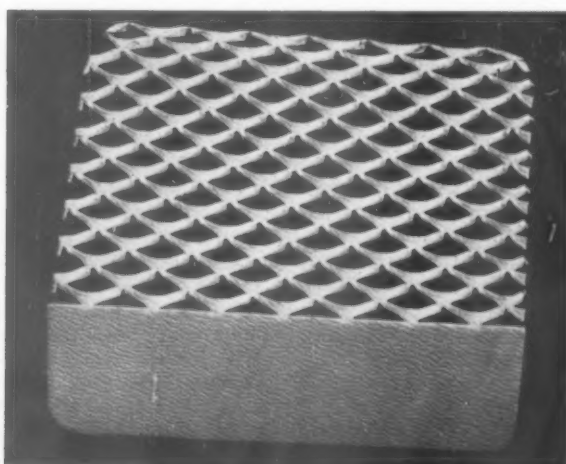
Panels can be secured together by spot-welding at the marginal flanges provided the P.V.C. coating is first removed. This is effected simply by running over the flange with a heated iron furnished with a shouldered bit by which it is guided from the flange edge. Alternatively, the appropriate width of the flange could be cleaned by "wheeling" the panel between heated rollers. For lightly stressed structures, panels can be joined if the P.V.C. coatings of abutting flanges are welded together by normal plastics high-frequency welding equipment. Any attachment or fitting of plastics, a decorative motif, badge, name-plate or the like, can be permanently affixed to the coated surface of a panel by the same method. Similarly, for a detachable panel the cut edge may be closed by a channelled strip of P.V.C. or a decorative bead or moulding. An application of particular interest for vehicle interior trim, an inner door panel for instance, is the method of attaching an upholstered or padded sheet of P.V.C. directly to the coated panel by H.F. welding around the margins. Decorative material of this type is available in a wide range of colours, embossings, and patterns.

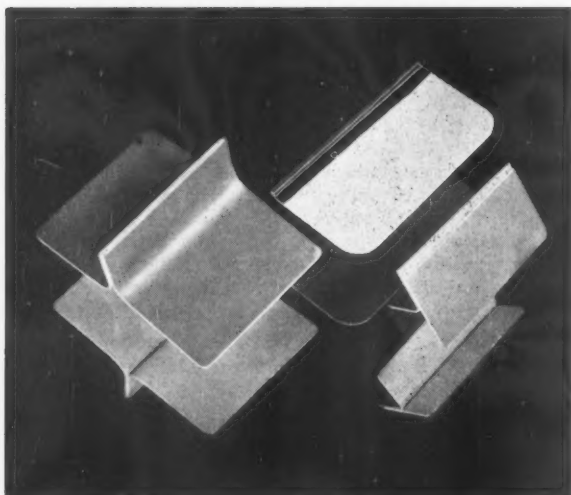
The securing of metal fittings or means of attachment to the metal surface of Stelvetite can be readily effected by

Test cups illustrating the "drawability" of Stelvetite sheet. No draw marks appear on the externally coated example

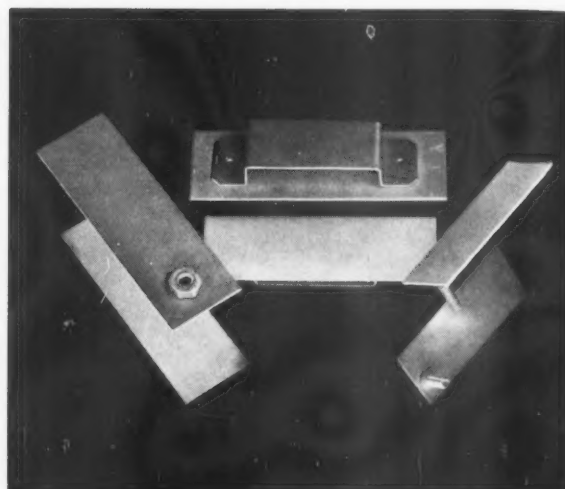


A specimen showing the adhesion of the P.V.C. coating under exacting production conditions





Assembly of fabricated parts by H.F. welding of the P.V.C. coatings. Seams can be filled with P.V.C.



Projection-welded nuts and studs. Mirror view to show unaffected P.V.C. coating

the method of projection welding without in any way damaging the coated external surface. An illustration shows examples of this technique; the articles are placed on a mirror so that both sides can be observed simultaneously.

Since the coating is resistant to acid it is possible to electroplate either the metal surface or cleared areas or margins of the coated surface, should this be desired for either constructional or decorative purposes. The only limitations in the process are that the aqueous plating solution should be of not more than 30 per cent acidity and that the operating temperature of the solution should not exceed 150 deg F. Providing these limits are observed the P.V.C. coating will be unaffected.

One aspect of production, of some importance, is that press trimmings, cut-offs, and waste Stelvetite relegated to scrap do not need to be segregated. Since P.V.C. is a carbonaceous material it has no deleterious effect and can be sent to the furnace with the normal steel scrap. Thus existing methods of scrap collection and disposal require no modification or reorganization.

Although it is more costly than ordinary sheet steel, Stelvetite eliminates the need for surface finishing treatments and thus shows an overall economy. Production plant, material, time, and labour can be saved. It is cheaper, easier to work and does not require the finishing of stainless steel.

Although a large scale plant has been brought into operation and production is in quantity, supplies of Stelvetite are not unlimited. Already they are being drawn upon by an extensive range of industries, all potentially large consumers. For the motor industry the immediate applications are for interior furnishing and trim; door panels, seat backs and fascia boards are obvious examples. The potentialities of the material for the main body shell, however, should not be overlooked. Necessarily, a complete shell would be a later development, since a body would need to be designed specifically for fabrication in the new material to secure the optimum advantage.

Somewhat more care would be necessary in handling in the shops, but the colourful, finished appearance of the sheet stock—it is supplied clean and interleaved with paper—creates a good psychological impression. It has already been noted that operatives refrain from walking on Stelvetite sheets; an all too common practice that cannot be completely eradicated when the usual oiled sheet steel stock is used.

Certainly cleaner working conditions will be possible in the press shop.

Constructionally, no major problems are envisaged. It is a definite advantage that conventional tools and equipment can be used, as with ordinary sheet steel, and familiar production methods followed. The problem of protection against corrosion, atmospheric or electrolytic, is no worse than with ordinary steel and, particularly in the case of the electro-zinc coated sheet, may be considerably easier of solution. Cut edges may be folded or rolled to enclose the edge or a P.V.C. moulding or extrusion can be used to seal it. Seams between panels can be filled with P.V.C. and smoothed or radiused to present an unbroken surface by a method closely resembling the solder filling of seams in ordinary steel bodies. Hot-gas torches, either acetylene gas-heated or electrically heated types, are used with a



Upholstered P.V.C. sheet attached to P.V.C. coating of Stelvetite panel by H.F. Welding

filler rod of a composition identical with that of the coating. The heated gas may be compressed air or nitrogen. Suitable torches and equipment are manufactured by Rediweild Ltd, 15-17 Crompton Way, Crawley, Sussex.

Since Stelvetite is supplied as a finished material it should be treated as such in the workshop. Research, development and testing of the new material have been conducted over a period of years and extensive experience has been accumulated on methods of handling, working, and fabrication. Manufacturers are invited to consult with the producers to ensure that the best possible results are achieved. In any circumstance it is advisable to state the application for which Stelvetite is intended so that the correct grade of steel and the most suitable formulation of plastic can be supplied.

Engine Lubrication

Tests on a Compound Based on Molybdenum Disulphide

IN the past few years the lubricating properties of molybdenum disulphide (MoS_2) have been the subject of many investigations and tests which have proved that this solid lubricant has very valuable properties, particularly in applications where pressures and temperatures are high. Some recent tests, which are described in these notes, are of special interest to automobile engineers. They were concerned with "Auto-Moly," an MoS_2 engine compound developed by Charham Products Ltd., 5a Market Place, Acton, London, W.3, for use in internal combustion engines.

Auto-Moly engine compound is made from the purest refined molybdenum disulphide. Its average particle size of under one micron is suitable for passing through any normal filter. It is an almost inert substance and is completely non-toxic. The purpose of the tests was to determine whether the surfaces formed after Auto-Moly had been added to the oil were strong enough to permit the engine to run (a) in conditions of oil starvation, and (b) without any oil at all.

The test vehicle was an Austin A50 Countryman van with a factory-reconditioned engine. It was run in on Shell oil to which Auto-Moly had been added. The big-end bearings were of lead-indium, and the main bearings of babbitt white metal. After 872 miles, the engine was stripped and inspected by Milne and Russell Ltd., of Croydon.

Condition of engine after running-in

Inspection of the cylinder walls and pistons showed that a very useful bonded coating of MoS_2 had already been applied to metal surfaces. The usual bright, highly polished surface finish was observed to be complete throughout all units. It was noted that the small amount of carbon deposit present on the top of each piston was adhering very loosely and flaked off almost at a touch, leaving a clean MoS_2 -coated surface below. This, it is felt, is evidence of the cleansing action of Auto-Moly in limiting the formation of carbon deposits.

Valves, valve guides, stems, big-end side faces and the faces of the crankshaft webs were all well coated with MoS_2 and showed polished surfaces. There was also some evidence of MoS_2 adhering to the bright surfaces of the white metal bearings. For later comparison, all wearing parts of cylinders, piston rings, crankshaft, bearings, etc., were accurately measured.

In order to provide accurate data on engine performance, the following additional instruments were fitted.

- (1) A Redex vacuum gauge to indicate engine performance through negative boost readings (fitted on top of manifold).
- (2) Oil temperature gauge with connection to the bottom of the oil sump to give an indication of operating temperatures below the crankshaft. Readings in air instead of liquid to be computed above indicated temperatures.
- (3) Oil pressure gauge.
- (4) Radiator temperature gauge.

Approximately 5 oz of Auto-Moly were added to the gearbox and back axle. It was seen that the gearbox, though recently topped up, was practically empty. This was due to a faulty seal, which was not discovered until considerably later.

To complete the running-in over a sustained period at high speed, and to test the performance of the vehicle, a run was made to Exeter on the A30 road. During a prolonged run at speeds from 60 to 80 m.p.h., the temperature gauges were both allowed to reach maximum, 212 deg F, and stops were made to check oil and water levels, and exhaust and idling performance.

Boost level readings were noted for different throttle settings, and, as far as possible, fuel consumptions were determined for various speeds. It was found that for a reading within the recommended gauge limit of 18-20 in, the economical speed/consumption level was approximately 42 m.p.h. The actual readings were:—

40/65 m.p.h.	28 m.p.g.
40/45 m.p.h.	32.5 m.p.g.
30/35 m.p.h.	30 m.p.g.

These figures were required for comparison with later readings obtained during the oil-free run.

Test 1—Oil starved conditions

For this test, the engine sump was first drained and then approximately 1½ pints of Auto-Moly were put into the sump. For the next 300 miles—Torquay, Mevagissey, Crediton—the vehicle was generally driven at normal speed, and at times at high speed, with an oil pressure reading of approximately 10 lb/in², as against the average of 60 lb/in² when running on a full sump, to check temperatures and general engine behaviour.

Apart from oil pressure, no alterations were observed in instrument readings, performance, acceleration and fuel consumption. The readings at average cruising, 40-45 m.p.h. were:

	Sump full	Sump with 1½ pints
Boost	18-20 in	18-20 in
Oil pressure	60 lb/in ²	10 lb/in ²
Oil temperature	160 deg F	160 deg F
Radiator temperature	165 deg F	165 deg F

Test 2—Oil-free run

On 17th August, the oil sump was completely drained, approximately 1 pint was removed, at Crediton, Devon. The vehicle was then driven to Exeter and thence by A30 to London. Short stops for refreshment were made at Shaftesbury and Salisbury. The log for this journey is shown at the top of the next page. Boost was 18-20 in and the oil pressure nil throughout. Readings were taken at 30 m.p.h.

In the circumstances, the vehicle performed very well. There was no observable difference in performance apart from suspected sluggishness on longer hills, which, however, may have been psychological. With increased throttle, the boost behaved normally in dropping back, so no engine labouring could be established. The valve or bearing noise at low throttle became fairly continuous but was not excessive, since every care was taken to drive outside this trouble zone. The boost pressures were unaffected at 30 m.p.h. average cruising. Knocking was not apparent at idling speeds nor was any excessive smoke apparent at stopping points either from the exhaust or the oil filler cap.

Speedometer reading	Oil temp deg F	Radiator temp deg F	Remarks
62,696	120	160	Valve or bearing knock at low throttle
62,712	128	165	Still knock on low setting; free above and below
62,716	130	168	Speed acceleration the same as before
62,720	135	166	No change
62,725	140	164	No change
62,730	140	166	Practically no knock
62,740	140	166	Knocking at low setting
62,750	142	166	Same as before
62,770	140	168	Same as before
62,800	140	166	No change
62,805	140	170	More pronounced big-end noise
62,820	140	165	Knocking only at low throttle. O.K. above and below
62,850	138	165	Still knocking at low setting
62,900	140	166	Same

Second oil-free run

At a speedometer reading of 62,906 miles, the petrol tank was filled with three gallons of premium grade petrol and the vehicle was driven to Moons Garage, Victoria, where the sump was drained. This test consisted in a run to Brighton without oil. The test started at a speedometer reading of 62,910 miles and finished at a reading of 63,010 miles. At this point, the petrol level was the same as at the starting point. The average consumption was, therefore, slightly over 30 m.p.g., which is similar to the original finding.

It is interesting to note that on the 18th of August, after the oil-free run from Exeter, the engine started more easily than was normally the case. During the oil-free run to Brighton, vehicle performance was in every way similar to that of the run from Exeter to London. Temperatures, pressures, acceleration and behaviour were normal. Excess knocking did not become apparent, although it must be noted that care was taken to drive outside the limits of the knocking zone on the throttle.

To conclude the test, the vehicle was driven locally in London for demonstration purposes, without oil in the sump. At a mileage of 63,191, the vehicle was returned to Milne and Russell Ltd., for stripping and examination.

Test Results

A glossier and more evident bonded coating of MoS_2 was apparent on the cylinder walls and there were no discernible marks of scoring. The pistons were unmarked, and the rings were highly polished and the ridging left after manufacture was still in its original state. No measureable wear had taken place.

Camshaft, valves, valve guides, stems. These showed no change and no measurable wear. All the components were in a clean state with no signs of sludging.

Connecting rods. The small-end bearings showed no observable signs of wear. Each lead-indium big-end bearing shell had, to a greater or lesser extent, lost part of its soft facing. In the case of Nos. 1 and 3 bearings, the facing had been removed somewhat unevenly, particularly about the oil hole. This wear can be assumed to be due to hammering without the normal cushioning effect of an oil film. It could no doubt be reduced or eliminated by the fitting of solid phosphor bronze bearings with a closer clearance. From a depth point of view, the overall wear was only slightly more than the usual limits expected for a normally lubricated bearing over a similar working period.

Crankshaft and main bearings. Some evidence of scoring was apparent on Nos. 1 and 3 bearings at points immediately

opposite each oil hole in the bearings shells where the facing had been removed unevenly. The depth of wear was, however, well within normal limits. The main bearings and shells showed no observable signs of wear and were even throughout the area of each surface.

Observed measurements

Cylinder bore wear, in				
	No. 1	No. 2	No. 3	No. 4
Measurement before running	2.6085	2.6085	2.6085	2.6090
Measurement after running	2.6090	2.6090	2.6090	2.6100
Crankshaft wear, in				
	Before running	After running		
Main journal measurement	1.981	1.979		
Crank pin measurements before running			1.856	
Measurements after running	No. 1		1.851	
	No. 2		1.852	
	No. 3		1.852	
	No. 4		1.852	

It is almost unnecessary to say that these tests were not run to show that lubricating oil can or should be dispensed with. The primary aim was to prove that Auto-Moly, when added to the lubricating oil of an internal combustion engine, is rapidly and evenly dispersed throughout the engine, and because of its natural attraction, bonds to the metal surfaces to form a layer of immense and lasting bearing capacity, which reduces friction and gives added lubricant protection.

Counterbalanced Push Travel Truck

ECONOMY of operation in materials handling for short distances is claimed for the TPS MachinLoder recently developed by Trucks and Pallets (Stackers) Ltd., Gas Street, Birmingham, 1. This truck has been developed to replace high-priced, power-driven equipment. It has extremely low traction resistance and is simple to move and manoeuvre by means of positive tiller steering. The truck is counterbalanced and of very small size so that it can be used in restricted spaces where larger equipment would be completely unsuitable.

The design is such that the truck can be placed flush with a machine without obstruction at the base. As a consequence the loading of lathes, presses, milling machines, and process plant is greatly simplified. A 4 ft 6 in lift from floor level is obtainable by manual or battery electric means. The standard rating of 500 lb at 12 in centres gives a safety factor of approximately 80 per cent. Alternative ratings of 750 lb and 1,000 lb are available.

The TPS MachinLoder is built from high quality materials and components with ball and roller bearings throughout. The hydraulic system is sturdy and thoroughly efficient. In addition to being used for loading, it can be employed equally effectively for pallet handling in confined spaces. With additional fittings it can be adapted for many other applications and operations. Removable 24 in forks are fitted as standard. The optional extras are:—

- (1) 20 in jib
- (2) Squeeze clamps
- (3) Roller platform

Other versions of the TPS MachinLoder are available, with load capacities of 1,000 lb and 2,000 lb at 24 in centres with lifts up to 6 ft.

Safety Belts

Details of a Device to Minimize Injury

MODERN coachwork, particularly when composed entirely of steel and the unitary method of construction is used, is extremely strong. It offers a high degree of protection in the event of accident, but this in itself is not enough to ensure freedom from injury to the car occupants. It has been proved that a car may somersault several times without very serious damage, but obviously under these conditions those inside the car would undoubtedly suffer injury. In recent years a number of ideas have appeared to improve the safety of those seated in the car, and quite frequently the padded windscreen facia has been used, this giving a pleasant finish, quite apart from its efficiency. In some countries, particularly America and Sweden, interest has been shown in the safety belt, an idea obviously inspired by the similar device that is used in aircraft.

The provision of a safety belt is not perhaps quite so simple as it may sound, for little thought is needed to determine that however strong the belt in itself may be, its efficiency will be rendered negligible if the attachment to the car is weak. A very close study of this matter has been made in Sweden, where from accident statistics it was proved that the driver, of all the occupants in the car, had the greatest protection in the event of accident, only 6 per cent of drivers being injured. His fellow front-seat occupant ran the greatest risk with a figure of 70 per cent, while the two rear seat occupants each carried a figure of 12 per cent.

As a result of these studies and in conjunction with aircraft authorities, a Swedish safety belt was devised and is now being offered in this country by Delaney Gallay, Vulcan Works, Edgware Road, London, N.W.2. It is made in varying styles to suit the different types of seat now being used, but its salient feature is the provision of shoulder straps in addition to the waist belt. A waist belt would hold a passenger to the seat but in the event of a severe collision the shoulders would be thrown forwards and internal injury might well result. It is to minimize this possibility that the shoulder strap idea has been introduced.

The safety belt under review is known as the R.K.N., and is composed of grey-blue Terylene material which has been tested to withstand a load of one ton, in fact a vehicle of this weight has been suspended by the belt alone. The lap strap has a central lock which may be released with one finger and this, of course, is essential if the safety strap is to cause no inconvenience to a person entering or leaving the seat.



The R.K.N. safety belt produced by Delaney Gallay Ltd.

The whole efficiency of the safety strap lies, as previously stated, in the attachment to the car, and it would obviously be undesirable to rely solely on the seat fixture. The attachment is, therefore, made to a $\frac{3}{8}$ in. loop bolt that is passed through the steel floor with load spreading plates above and below the floor. Where a timber floor is encountered the loop bolt is passed through to secure a fixture to a convenient chassis member, although some difficulty might be experienced here in the case of bodies using a flexible mounting. No doubt in such a case further stiffness could be introduced into the floor itself.

The point of attachment to the floor itself varies according to the type of seat under consideration, and the method that causes greatest inconvenience in the rear compartment is the one to be adopted in the case of seats having tilt backs. For the normal rigid-backed seat, the attachment encroaches to only a small degree on the rear floor area, and there is a third method which offers no encroachment at all. Now that interest has been shown in the use of safety straps for cars exported to the United States of America, there seems little doubt that this safety precaution will be fitted in increasing numbers on cars used in this country.

FURNACES FOR THE ALUMINIUM INDUSTRY

DURING 1957 The Morgan Crucible Company Limited, Battersea Church Road, London, S.W.11, introduced a new electric die-casting furnace and a new oil-fired, basin tilting furnace after a considerable period of research. The die-casting furnace was developed in collaboration with Birlec Limited of Birmingham. It is a crucible furnace, electrically heated, of 300 lb charge capacity for maintaining aluminium and aluminium alloys, and combines the proved advantages of crucible melting with the undoubted benefit of electric heating.

The electric die-casting furnace has fully automatic temperature control, which keeps the metal accurately at the specified casting temperature, thereby relieving the operator of all furnace duties, so that he can concentrate on die-casting. Automatic control of electric heating ensures

constant performance from the furnace and complete freedom from variations in metal quality. If an automatic time switch is fitted, the furnace can be ready for use at the start of the shift, without requiring an operator to switch it on before the normal working time.

The basin tilting furnace is complementary to the die-casting furnace, since it is a bulk melting furnace for feeding maintaining furnaces. It has all the qualities necessary for a bulk melter; a high melting rate, simple operation and lip pour. These qualities, coupled with crucible melting, give highest quality metal with minimum metal loss. A special feature of this basin tilter is the built-in tilting mechanism which gives a smooth lip pour with finger-tip control. The resulting steady stream of metal allows the ladles to be kept in one position throughout the pour.

DIESEL ENGINE PERFORMANCE

A Technique for Reducing Smoke and Improving Output*

M. ALPERSTEIN, W. B. SWIM, P. H. SCHWEITZER

FUEL economy is the outstanding advantage of the diesel engine. This derives from two facts; the compression ratio of the diesel is roughly double that of the automobile petrol engine, and the diesel can burn a lean mixture that a spark is unable to ignite. In most other respects, however, the diesel is inferior to the Otto engine. In the latter the fuel and air are mixed *before* they enter the cylinder and most of the fuel is in the vapour phase at the time of ignition. Therefore a rather rich mixture can be completely burned without thermal decomposition; hence carburettor engines generally do not smoke. Secondly, the spark plug is able to ignite fuels of low ignition quality, which in a compression-ignition engine would either ignite too late or not at all.

The technique described in this report represents a little step away from the diesel engine in the direction of the Otto engine. It is a step that preserves all the diesel advantages and alleviates two disadvantages, incomplete mixing of air and fuel and late combustion caused by long ignition lag. Broadly, the method consists in introducing part of the fuel in a fine mist or fume into the intake manifold while the remainder is introduced in the conventional manner through the high pressure injection system into the cylinder near top dead centre position of the piston.

Manifold introduction of fuels into a compression-ignition engine was experimented with at Pennsylvania State University as early as 1941, and is reported in the master thesis of C. W. Overbeke, "Manifold Introduction of Hydrocarbons as an Aid for Starting," August, 1942. Various means of vaporization and carburation were used for introducing auxiliary fuels such as hexane, heptane, five different diesel fuels, white petrol, hydrogen peroxide, benzoyl, methyl alcohol, benzene, cetane and diethyl ether. Ether, cetane, hexane and low boiling point diesel fuels were found to be the most effective; acetone, benzene and ethyl alcohol were least effective or were detrimental when introduced into the intake manifold. It was pointed out then that slow oxidation

and pre-flame reactions were believed to be responsible for the effect on ignition of the manifold introduced fuels.

McLaughlin, Pinotti and Sigworth¹ used manifold introduction of fuels—mostly petrol and liquid petroleum gas—to kill smoke and/or boost power, as was also done by Derry² and others and by Lyn³ in England. In all these researches the main fuel was injected into the diesel cylinder in the conventional manner and a smaller amount of auxiliary fuel was introduced into the intake manifold as an aid to combustion. Havemann⁴ and others, on the other hand, carburetted alcohol as a main fuel and injected a small amount of diesel oil and various vegetable oils to ignite the compressed air-alcohol vapour mixture. In this manner they successfully burned alcohol, which otherwise could not be ignited by compression ignition. A similar scheme was used during the war by the German air force. They developed the "R Fluid," a less volatile ether, which they used in place of a spark plug. Ignition was produced by the injection of "R Fluid," before top centre, into the compressed air-petrol vapour mixture. Still earlier, a pilot spray of diesel fuel was used in the same manner in dual-fuel gas engines.

In the last three instances the main fuel was inducted through the intake manifold and a relatively small amount of auxiliary fuel injected. But ignition was always released by the injected fuel. In fact, without the injection of a liquid jet, the gaseous main fuel would not ignite at all, except at a very high compression ratio.

Most recently, Arnold⁵ and others used supplementary fuels of high ignition quality to help burn low ignition quality fuels, which otherwise would burn only sluggishly or not at all. Previous investigators used injection nozzles or carburettors to introduce supplementary fuel into the intake air. Such devices give rather coarse sprays with a mean drop size of 20 microns or more. For the investigations on which this paper is based, an apparatus called Micro-Fog was employed. It produces a very fine mist consisting of droplets under 4 microns. This gave amazingly good results. Subsequently, the investigations were extended to cover a

*A report on work carried out in the Department of Engineering Research, Pennsylvania State University.

TABLE I. FUEL PROPERTIES

Fuel	Chemical constitution	Spec. gravity (60/60) deg F	Kin. viscosity cS at 100 deg F	Boiling point deg F	Octane number	Cetane number	Latent heat of evaporation B.Th.U./lb	High heating value B.Th.U./lb	Low heating value B.Th.U./lb	Stoichiometric air:fuel ratio
N-hexane	C ₆ H ₁₄	0.659	0.41	155	26		156	20,900	19,432	15.2
N-heptane	C ₇ H ₁₆	0.684	0.52	209	0		155	20,850	19,408	15.1
Ethyl alcohol	C ₂ H ₅ OH	0.785	1.11	172	99		367	12,780	11,604	9.0
Diethyl ether	(C ₂ H ₅) ₂ O	0.714	0.28	94.3			165	15,840	14,560	11.1
Amyl nitrate	C ₅ H ₁₁ NO ₃	1.000	0.80	297			150	10,600	9,810	7.48
Iso-propyl nitrate	(CH ₃) ₂ CHNO ₂	1.058	1.82	216			137	8,210	7,580	5.55
90 octane primary	90% C ₈ H ₁₈	0.701	0.58	211	90		155	20,600	19,184	15.1
Ref. fuel blend	10% C ₇ H ₁₆									
Diesel fuel, WCN	H/C=0.154	0.850	2.7	680 E.P.		43.6		19,610	18,260	14.5
Diesel fuel, CCD	H/C=0.156	0.836	2.75	623 E.P.		52.4		19,780	18,430	14.5
JP-5	H/C=0.134	0.883	1.27	504 E.P.		22.9		19,380	18,075	14.3

TABLE II.
STANDARD CONDITIONS FOR CFR ENGINE TESTS

3½ in bore, 4½ in stroke, 900 r.p.m.	17 : 1 compression ratio
Lubricating oil	S.A.E. 30
Lubricating oil temp. deg F	135±1
Lubricating oil pressure	25-40 lb/in ² g, depending upon speed
Water jacket temperature, deg F	210±1
Injection angles	6 deg B.T.C. for 600 r.p.m., 7-13 deg B.T.C. for 900 r.p.m., depending upon the test
Inlet air temperature, deg F	15 deg B.T.C. for 1,200 r.p.m.
Inlet air pressure	100±2*
Exhaust gas pressure	Atmospheric±0.3 in Hg† 1.0±0.5 in water

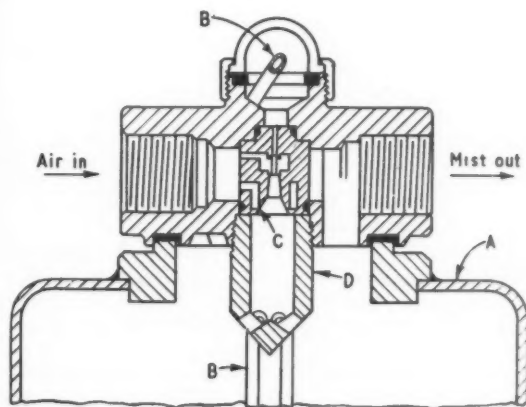
*Inlet air temperature was above 100 deg F in the tests run with the vaporizer unit, and the actual value for temperature depended upon the fuel used and the rate of introduction.

†A series of tests was run under supercharged conditions in which the inlet pressure was maintained at 5 in Hg gauge.

TABLE III.
**STANDARD CONDITIONS FOR PETTER
AVA-1 ENGINE**

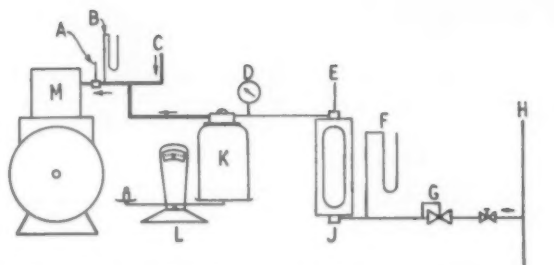
Lubricating oil	S.A.E. 30*
Injection angles, not adjustable	24 deg B.T.C. up to 1,500 r.p.m. 28 deg B.T.C. 1,500 to 1,800 r.p.m.
Inlet air temperature	Room temperature
Inlet air pressure	Atmospheric —0.6 in H ₂ O at 900 r.p.m. —0.9 in H ₂ O at 1,200 r.p.m.

*S.A.E. 10 oil was used for the non-firing tests.



A fuel tank; B fuel riser; C atomizer holes, four; D diffusion plug

Fig. 1. Above: Cross section of Norgren Micro-Fog



A inlet temperature; B inlet pressure; C air intake system; D pressure gauge; E air temperature; F air pressure; G regulator; H compressed air service line; J Rotameter; K Micro-Fog unit; L sensitive scale; M CFR engine

Fig. 2. Micro-Fog supplementary fuel system

variety of auxiliary fuels and several methods of introduction. The properties of the fuels used are given in Table I.

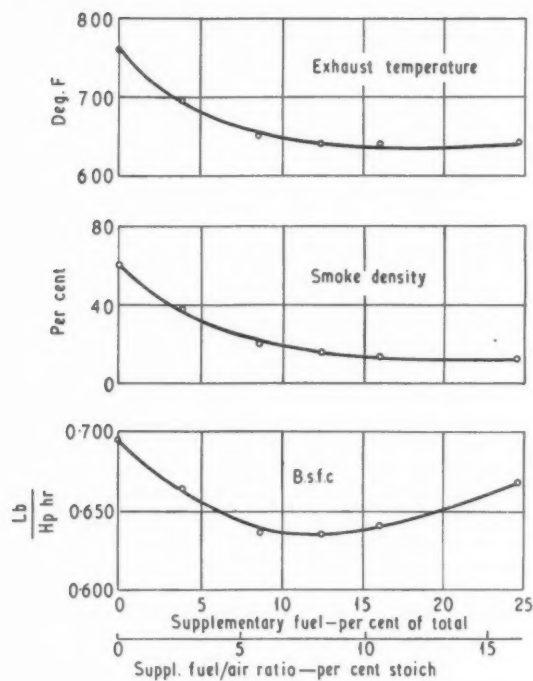
Test equipment

Most of the tests were performed on a single-cylinder CFR cetane test engine, but some were carried out on a single-cylinder Petter AVA-1 diesel engine. The CFR engine has a Ricardo Comet type swirl chamber head and a fixed compression ratio of 17 : 1. The Petter engine was of the open chamber type with a compression ratio of 16.5 : 1. It was air cooled. Tables II and III give the standard operating conditions for the two engines.

Supplementary fuel was introduced by four different methods: a mist generator, a commercial pneumatic spray nozzle, a carburettor, and vaporizer. The mist generator was an experimental model of the commercial Micro-Fog lubricator made by C. A. Norgren Co. A cross-section of the device is shown in Fig. 1. In operation, liquid passes through air jets issuing from four atomizer holes. The so atomized liquid is then carried by the air through a series of separator



Fig. 3. Right: Micro-Fog installation on CFR engine



B.m.e.p. 57.7 lb/in². Both fuels 44 C.N. diesel fuel. Supplementary fuel introduced by Micro-Fog. CFR engine, 900 r.p.m. Injection begins at 13 deg B.T.C.

Fig. 4. Effect of supplementary fuel on engine performance at constant brake load

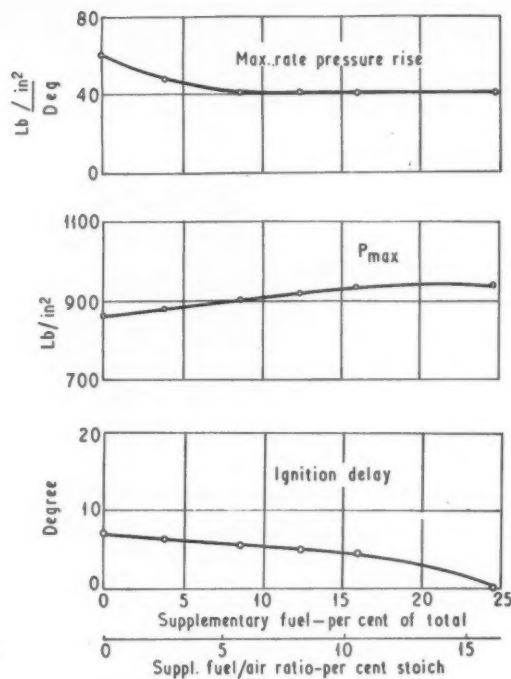
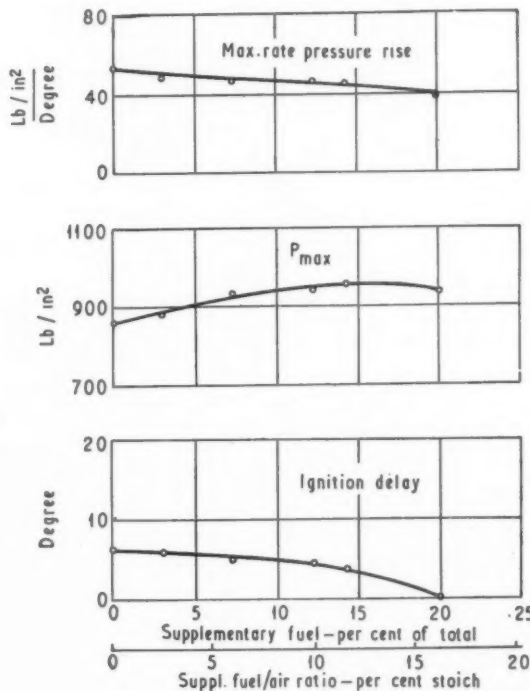
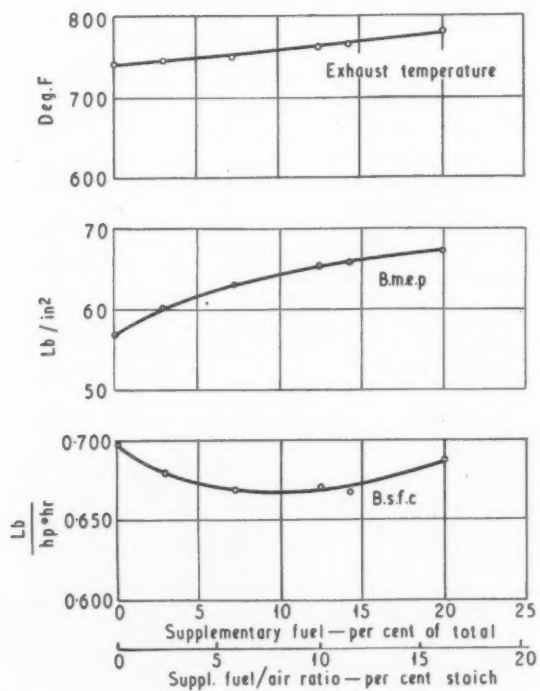


Fig. 5. Effect on ignition lag and rate of pressure rise at constant brake load

Fig. 6. Effect on exhaust temperature, power and fuel consumption at constant smoke density, 60 per cent

Fig. 7. Effects on pressure and ignition lag at constant smoke density, 60 per cent

Both fuels 44 C.N. diesel fuel. Supplementary fuel introduced by Micro-Fog. CFR engine, 900 r.p.m. Injection begins at 13 deg B.T.C.



passages where the heavier droplets are removed. The remaining mist is then conveyed by the air stream with controlled pressure into the manifold. This mist, the drop sizes are all under 4 microns, is so fine that it does not wet a hand or a glass surface held in front of it.

The pneumatic atomizing nozzle used in the test programme was made by Spraying Systems Co. The fuel rate was controlled by means of a needle valve feeding to a constant head fuel reservoir. Air at pressures ranging from 10-15 lb/in² passed through an annulus around the fuel nozzle and impinged upon the fuel, thus atomizing it. Air flow requirements were less than 1/40th those of the Micro-Fog, but the mass median droplet size was 59.5 microns, a rather coarse spray.

The carburettor was adapted from a Briggs and Stratton 2½ h.p. engine carburettor. It comprised a venturi, a metering orifice and a constant head fuel reservoir. Fuel was introduced into the fuel reservoir from a fuel tank by a needle valve controlling the supplementary fuel rate. The carburettor was mounted in a by-pass of the primary air supply line. In operation, a constant percentage of the engine air requirements passed through the carburettor. The atomized fuel, carried by this by-passed air, joined the primary air supply and was then admitted to the engine. To ensure adequate air-flow through the carburettor, throttling of the primary air line was necessary.

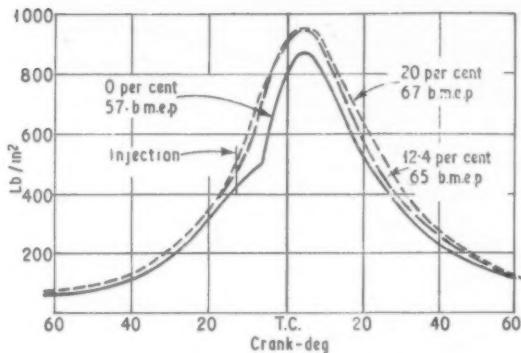
The vaporizer consisted of a metal container through which all the air to the engine was fed. Fuel was fed to the vaporizer from a gravity feed tank controlled by a needle valve. The bottom of the container was electrically heated above the boiling point of the supplementary fuel so that the fuel would flash immediately upon hitting it. This resulted in high intake air temperatures, depending upon the supplementary fuel used.

Instrumentation for the tests included: strain gauge type and piezo-electric pressure pick-ups and an oscilloscope with camera to record pressure-time traces, a stroboscopic timer, flowraters to measure primary and supplementary air flow, an electric air heater, exhaust gas and inlet air thermocouples, CRC and Von Brand smoke meters, and a General Radio noise level meter. The majority of the tests were conducted with either the smoke density or the brake load held constant. A diagrammatic sketch of the test set-up with the CFR engine and the Micro-Fog is shown in Fig. 2, and the actual set-up is shown in Fig. 3.

Tests with normal fuels

The results of constant brake load tests are shown in Figs. 4 and 5. A good grade of 44 C.N. fuel was used for both the main and supplementary fuels. The Micro-Fog device was used for introducing the supplementary fuel. It can be seen from Fig. 4 that the addition of the supplementary fuel caused a reduction in smoke density from 60 per cent (full load starting point) to 12 per cent. A significant decrease in the fuel consumption, 8.6 per cent at 11 per cent supplementary fuel, was also noted, with a marked decrease in exhaust gas temperature. Fig. 5 shows that the ignition lag drops to zero at 24 per cent supplementary fuel rate; then pre-ignition occurs. Smoother, quieter operation was obtained owing to the lower rate of pressure rise, although the maximum pressure increased.

Figs. 6 and 7 show the results when the smoke density was kept constant at 60 per cent CRC smoke meter reading, which is barely visible exhaust. The b.m.e.p. was found to increase about 18.6 per cent when 20 per cent of the total fuel was supplied with the intake air, and the fuel consumption was found to decrease only about 4.3 per cent when the supplementary fuel was approximately 10 per cent of the total. Firing pressures and rates of pressure rise change as in the constant brake load tests, but ignition delay becomes zero at 20 per cent supplementary fuel rate.



44 C.N. diesel fuel used for both main and supplementary fuels. CFR engine, 900 r.p.m. Injection begins at 13 deg B.T.C.

Fig. 8. Pressure diagrams for 0, 12.4 and 20 per cent supplementary fuel at constant smoke density

Superimposed pressure diagrams for normal injection and for two rates of supplementary fuel are shown in Fig. 8. The higher compression pressure when supplementary fuel is used indicates the presence of exothermic pre-flame reactions. It shortens the ignition lag and decreases the maximum rate of pressure rise.

The tests illustrated in Figs. 4-8 were performed with an injection advance of 13 deg B.T.C., which was the optimum injection angle for standard running. From the pressure traces, it appeared that later injection would further improve the engine performance. Tests with variable injection angles have indeed shown that specific fuel consumption decreased with retarding injection until the optimum was reached at 7 deg advance. The specific fuel consumption was then 9.8 per cent better with 14.5 per cent supplementary fuel than with normal operation.

In a conventional engine a slight advance of injection usually makes the engine rougher but improves the fuel consumption; on the other hand, when supplementary fuel is used the opposite result is obtained. This is shown by the following test results:—

Injection advance	Brake specific fuel consumption lb/b.h.p.-hr	
	Normal operation	10½ per cent supp. fuel
13 deg	0.635	0.624
7 deg	0.655	0.591

The smoke density was kept constant at 60 per cent during the tests. In Fig. 9 test results at 600, 900 and 1,200 r.p.m. are shown. At higher speeds the gain is greater.

Test results for three methods of introducing the supplementary fuel are shown in Fig. 10. These were constant smoke density tests and each of the three methods showed an improvement in performance. The greatest improvement was effected by using the mist generator. The vaporizer unit was penalized by the higher inlet air temperature necessary to operate the unit (250 deg F compared with 100 deg F). This was inherent in the operation of the vaporizer, since the plate used to vaporize the fuel also heated the inlet air. In order to avoid separation of the fuel from the air stream, there was no provision for cooling the inlet air prior to induction.

Fig. 11 shows superimposed indicator diagrams of normal and supplementary fuel cycles with the three different methods of introducing the supplementary fuel. It will be noted that for the greater part of the compression stroke the pressure increases for the vaporizer and Micro-Fog are

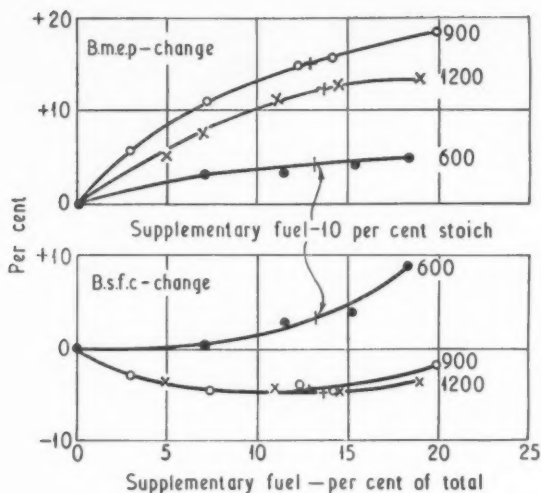


Fig. 9 The effect of engine speed on supplementary fuel addition at constant smoke density, 60 per cent

practically equal, but the Micro-Fog becomes more effective during ignition and combustion. In comparison with the vaporizer, the pneumatic spray nozzle produces less pressure increase before ignition but greater increase after ignition.

Tests were run using five different supplementary fuels; (n-heptane, n-hexane, alcohol, petrol and diesel fuel) in combination with various primary fuels and using three introduction methods. When diesel fuel was used as the supplementary, the mist generator gave the best results. As more volatile supplementary fuels are used, the method of introduction becomes less critical. Figs. 12 and 13 show the results of a series of constant brake load tests using the five different supplementary fuels introduced by the mist generator while injecting a high grade diesel fuel. The introduction of diesel fuel brought the greatest improvement. This is also true if the tests are run at the maximum load corresponding to 60 per cent smoke (CRC). Fig. 14 shows superimposed indicator diagrams for the five supplementary fuels.

Tests were conducted on the Petter AVA-1 engine to determine the effect in an open chamber diesel engine. The

pneumatic spray nozzle was used to introduce the supplementary fuel. The engine had a constant geometric timing of 24 deg B.T.D.C., and it was found that engine performance with neat 52 cetane fuel left little room for improvement. Constant heavy load tests gave, as shown in Fig. 15, smoke density and fuel consumption reductions of 33 per cent and 4 per cent respectively. With a low cetane, 31 C.N. injected fuel, the engine showed greater reductions in smoke density and fuel consumption (43 per cent and 10 per cent respectively) see Fig. 16.

The tests already mentioned were run with zero inch gauge pressure in the inlet manifold. By using shop air the inlet manifold pressure was raised to 5 in Hg gauge, and under these conditions indicator diagrams such as shown in Fig. 17 were obtained. They show that with supercharge the optimum amount of supplementary fuel is less than with natural aspiration. The optimum was obtained with 8.7 supplementary fuel, when the b.m.e.p. was 89.2 lb/in² and the specific fuel consumption was 0.581 lb/b.h.p.-hr, improvements of 9.4 per cent and 5.4 per cent respectively.

Sub-standard fuels

Long ignition lag is the reason for the unsatisfactory combustion of low cetane fuels. Since the technique used in these tests shortens the ignition lag, it was to be expected that it would facilitate the combustion of low cetane fuels. A 90 octane petrol, a mixture of 90 per cent iso-octane and 10 per cent n-heptane, was tried first. With only normal injection, the engine refused to run at low load and was erratic at high load. When approximately 20 per cent of the same fuel was introduced by Micro-Fog the engine ran steadily. Smoother operation was obtained by the introduction of 12 per cent of 44 diesel fuel into the intake manifold; this reduced the ignition lag from 20 deg to 10 deg C.abs. and the rate of pressure rise from 90 to 20 lb/in²-deg. The injection advance was 9 deg B.T.C. in these tests. Even so the operation was far from satisfactory and the fuel consumption excessive (0.73 lb/b.h.p.-hr).

The next primary fuel tested was a JP-5A fuel of 23 cetane number. With normal injection only, operation was unsatisfactory at light load and was impossible at idle. When straight amyl nitrate was used as supplementary fuel introduced by a carburettor at the rate of approximately 1/800 lb per lb of air there was a definite improvement. Steady and smooth operation was obtained down to idle, although the fuel consumption was high. N-propyl nitrate and iso-propyl nitrate gave similar results.

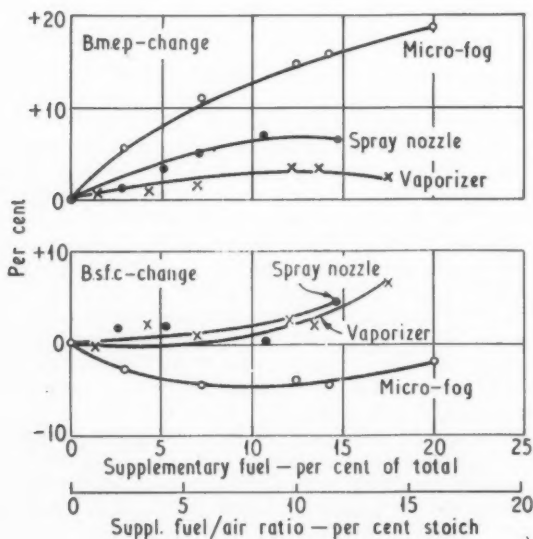


Fig. 10. Left: Effects of various methods of introducing supplementary fuel at constant smoke density, 60 per cent

Fig. 11. Below: Pressure diagrams for three different methods of introducing supplementary fuel at constant smoke density, 60 per cent 44 C.N. diesel fuel used for both main and supplementary fuels

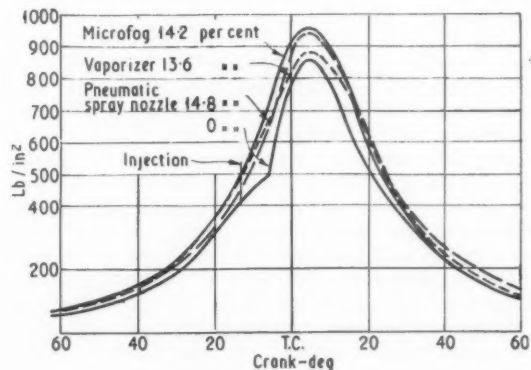


TABLE IV.

MINIMUM RATES OF SUPPLEMENTARY FUELS FOR STABLE OPERATION ON 29 C.N. MAIN FUEL; SUPPLEMENTARY FUEL; NEAT 52 CETANE FUEL

	Approximate minimum rate, per cent
Neat 52 cetane fuel	25
97.5 per cent 52 cetane and 2.5 per cent amyl nitrate	23
95 per cent 52 cetane and 5 per cent amyl nitrate	18
90 per cent 52 cetane and 10 per cent amyl nitrate	14

A constant amount of iso-propyl nitrate carburetted into the intake manifold gave the results shown in Fig. 18 with JP-5A primary fuel in the CFR engine. For this diagram, the total fuel consumption was plotted and the lower heating value of iso-propyl nitrate disregarded. Even alpha methyl naphthalene (C.N.=0) could be burned with this scheme. High cetane diesel fuel introduced by a pneumatic spray nozzle gave similarly good results.

Low load operation with low cetane fuel was still more difficult with the Petter engine. However, the engine could be made to operate satisfactorily on low cetane fuel if the proper supplementary fuel was used. Tests revealed that the type of supplementary fuel had a marked effect on engine operation, and that the higher the cetane number of the supplementary fuel the smaller the amount required for acceptable performance. Table IV shows the minimum rates of supplementary fuel, for several different types, required to obtain steady combustion when running on 29 C.N. fuel. Excessive amounts (upwards of 50 per cent) of low cetane supplementary fuel were required to achieve

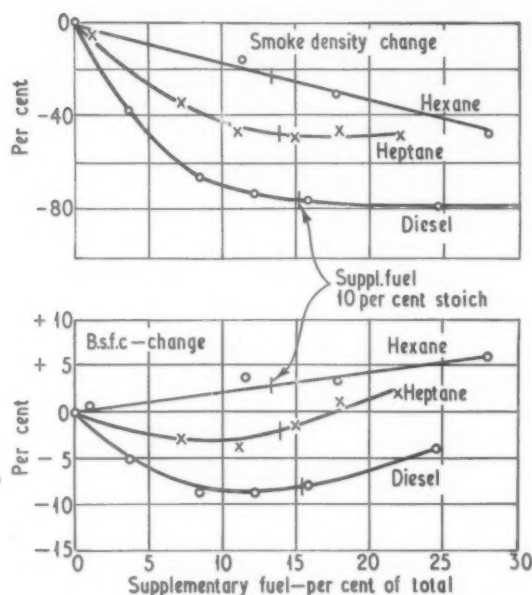


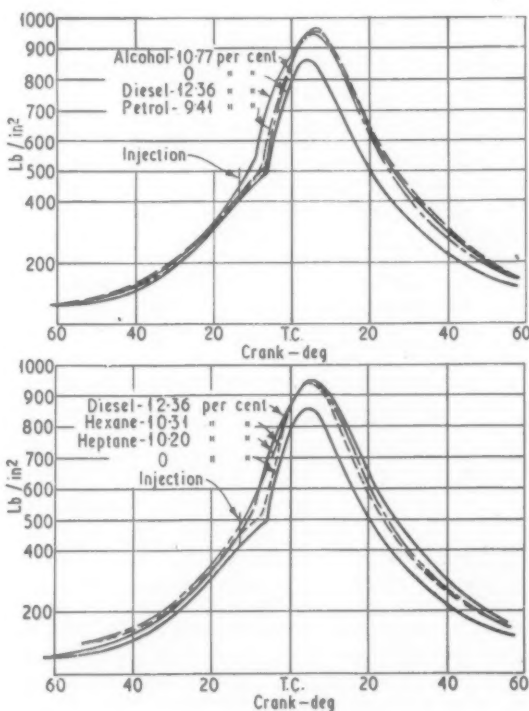
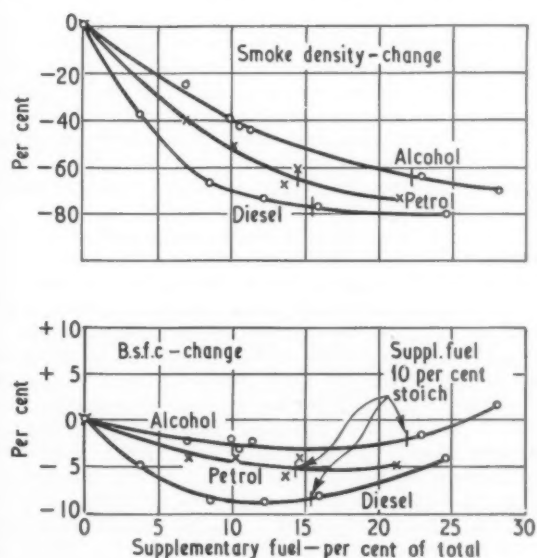
Fig. 12. The effects of hexane, heptane and diesel supplementary fuels on engine performance at constant brake load, b.m.e.p. 57.7 lb/in²

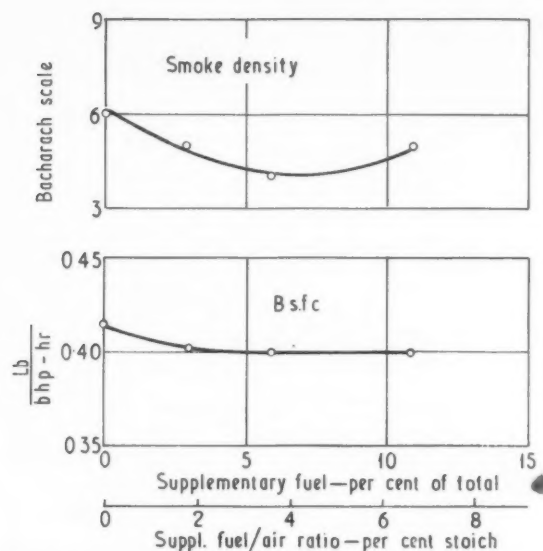
stable operation, and even then the performance was relatively poor.

It was thought that the addition of low viscosity supplementary fuel might result in poor lubrication of the cylinder walls, and because of this piston blow-by was watched continuously and an accurate record kept of the engine wear. The CFR engine has been run, using supplementary fuel, approximately 375 hours between overhauls. The blow-by did not increase appreciably during the course of the test programme, not did measurement of rings, cylinder and piston made during the overhaul period reveal any abnormal wear.

Fig. 14. Right: Pressure diagrams for various supplementary fuels on smoke density, 60 per cent. Primary fuel, diesel 44 C.N.

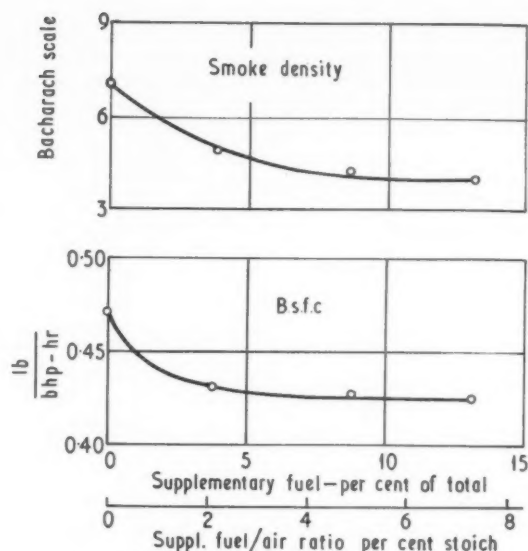
Fig. 13. Below: The effects of alcohol, petrol and diesel supplementary fuels on engine performance at constant brake load, b.m.e.p. 57.7 lb/in²





B.m.e.p. 97 lb/in². Both fuels 52 cetane. Supplementary fuel introduced by spray nozzle

Fig. 15. The effect of high cetane diesel supplementary fuel on smoke density and fuel consumption at constant brake load



Both fuels 31 cetane. Supplementary fuel introduced by spray nozzle

Fig. 16. The effect of low cetane diesel supplementary fuel on smoke density and fuel consumption at constant brake load, 86 lb/in²

How does it work?

It has been shown that Micro-Fog introduction of ordinary diesel fuel, in an amount approximately 15 per cent of the total, increased smoke-limited power output and also increased thermal efficiency. It can be imagined to help diesel combustion in two ways: better air utilization due to pre-mixing and more complete combustion due to the chemical effect. Of the earlier investigators, McLaughlin¹, Derry², Havemann⁴ attributed the improvements mainly to better air utilization, while Lyn³ emphasized the beneficial effects of pre-flame reactions on diesel combustion.

To analyze the factors contributing to improved engine performance on supplementary fuel and to determine the relative effect of each, Fig. 19 was prepared, using data from a constant smoke test in which both the fuel and air rates were measured. The increase in b.m.e.p. may have resulted from (a) the ability of the engine to burn more pounds of fuel per pound of air for the same degree of smoke density, better air utilization; (b) an increase in the thermal efficiency of the engine as a result of decreased ignition lag and faster combustion; (c) a combination of both. It was certainly not caused by the supercharging effect of the supplementary air because pressure and temperature were strictly kept at their standard values, atm ± 0.3 in Hg, 100 deg ± 2 deg F, for these tests except when a vaporizer was used.

With an excess air factor of λ and a stoichiometric air: fuel ratio of 14.5 the theoretical b.m.e.p. of the engine is:

$$\text{b.m.e.p.} = 180 \frac{\text{brake thermal eff.}}{0.325} \frac{\text{volume eff.}}{\lambda}$$

With x per cent supplementary fuel, that portion of the fuel needs no excess air ($\lambda=1$), therefore the increased b.m.e.p. will be:

$$\begin{aligned} \text{b.m.e.p.}' &= (1-x) 180 \frac{\text{brake thermal eff.}}{0.325} \frac{\text{volume eff.}}{\lambda} \\ &+ x 180 \frac{\text{brake thermal eff.}}{0.325} \frac{\text{volume eff.}}{1} \end{aligned}$$

From this the relative boost figures are:

$$\frac{\text{b.m.e.p.}' - \text{b.m.e.p.}}{\text{b.m.e.p.}} = x(\lambda - 1)$$

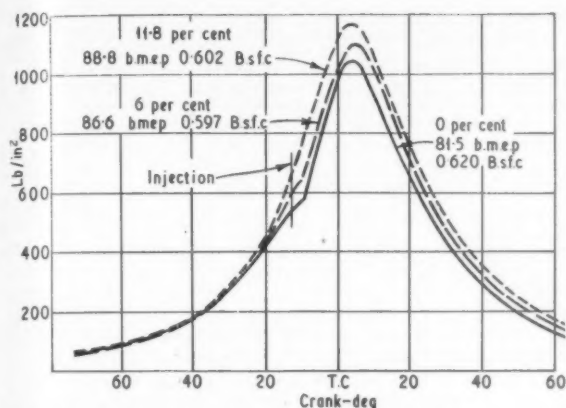
Under standard conditions the b.m.e.p. was 56.8, the brake thermal efficiency was 0.1856, the volumetric efficiency was 0.85, and the excess air factor was 1.54; therefore the relative boost would be $0.54x$ or roughly one half of the percentage

of supplementary fuel. The b.m.e.p. plot shows two curves, one the experimental curve and the other computed using a constant brake thermal efficiency. From this it can be seen that both factors contribute to the improved performance.

The investigations on which this paper are based show that both factors contribute to improved performance. In general it is correct to say that if power boost came from better air utilization alone, it would amount to less than the percentage of supplementary fuel, whereas the power increase was generally greater than the percentage of supplementary fuel. Improved combustion efficiency must have played a part. This becomes obvious from the great differences in the effects of supplementary fuels of different chemical compositions.

Pre-flame reactions can improve combustion in at least two ways. First, by shortening the ignition lag; secondly, by helping combustion after ignition has set in. Fig. 20 shows the effect on ignition lag of introducing, with Micro-Fog and with a vaporizer, increasing amounts of alcohol, 90 octane petrol, hexane, heptane and 44 cetane diesel fuel as supplementary fuels. It will be noted that the effect of alcohol and high octane petrol on the ignition lag is almost zero, while that of hexane, heptane and diesel fuel is very pronounced. But the effect on performance was not in the same order. As can be seen from Fig. 12, hexane reduced the smoke the least amount and actually increased the fuel consumption. On the other hand, alcohol and high octane petrol were far from without effect on combustion. They, then, must act through a mechanism other than shortening the ignition lag.

The manifold introduced fuel obviously exerts an influence on combustion in several ways. First, during the relatively long period of compression it is subject to slow oxidation, which, being an exothermic process, must raise the pressure and temperature of the cylinder charge more than if pure air were compressed. For this to happen, the hydrocarbon and oxygen molecules must be in contact, which can effectively occur only if the hydrocarbon is in gaseous state. Volatile fuels could be expected to excel in this effect. In this slow process of oxidation, however, few if any of the C molecules combine directly with O₂ molecules into CO₂ and the H₂ molecules with O molecules into H₂O. Combination takes place rather through the intermediate combustion products such as peroxides and aldehydes. The heat



Both fuels 44 C.N. diesel. Inlet manifold pressure 5 in Hg gauge

Fig. 17. Pressure diagram for a supercharged engine at constant smoke density, 60 per cent, and 0, 6.0 and 11.8 per cent supplementary fuel

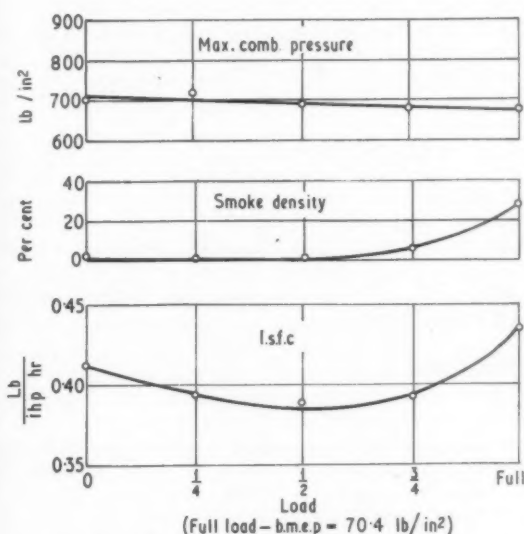


Fig. 18. The effect of using iso-propyl nitrate as supplementary fuel in conjunction with a low cetane, 23, main fuel

generated in such reactions is less, but these intermediate combustion products react more rapidly with oxygen than the original hydrocarbon. Therefore, slow oxidation may shorten the chemical as well as the physical portion of the ignition lag.

Parallel to the oxidation process another process is going on, that of pyrolysis or thermal decomposition, commonly called cracking. Under the influence of heat and pressure, the hydrocarbon molecule breaks into smaller molecules. This process is endothermic. It takes 80 kcal/mole to break a C-C bond, 100 to break a C-H bond, 150 to break a double bond C=C, and 200 to break a triple bond C≡C. For this reason such thermal decomposition may never take place if conditions of easy oxidation are present. Thermal decomposition can, however, take place in the absence of oxygen. The hydrocarbon need not be vaporized to crack.

Thermal cracking has been identified^{7,8}, as being responsible for soot deposits and exhaust smoke. But from the standpoint of ignition quality, hydrocarbons that crack easily like long chain paraffins are the best diesel fuels, and those that crack hard like ring chain aromatics are the worst.

No matter how undesirable cracking is after ignition, it is probably very helpful, perhaps essential, before ignition. R. O. King⁹ has put forth the theory that ignition generally is initiated by solid nuclei like carbon flakes. If the combustion air is free from such nuclei, a thermal decomposition of the fuel is needed which produces such carbon particles that can act as nuclei to initiate combustion. If the influence of supplementary fuel on combustion is through early oxidation, the volatile fuels of few carbon atoms should be best. If the effect is by speeding up ignition through thermal

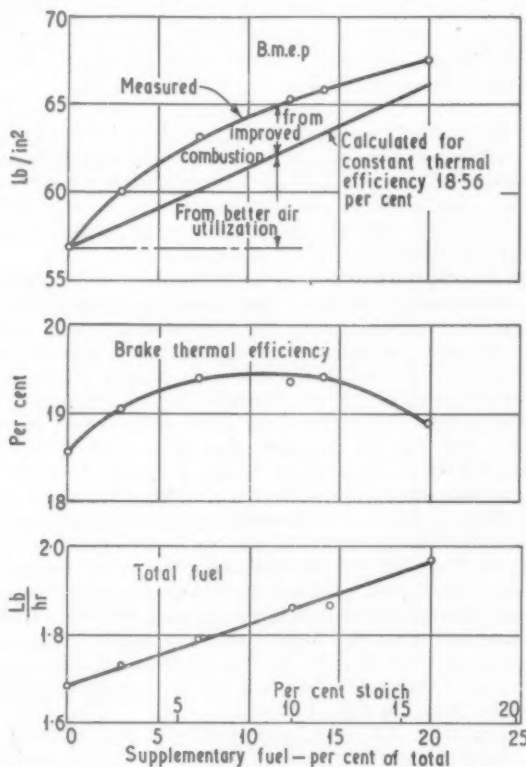


Fig. 19. Source of power increase with supplementary fuel introduced by the Micro-Fog unit

Fig. 20. Ignition lag against rate of supplementary fuel at constant smoke density, 60 per cent

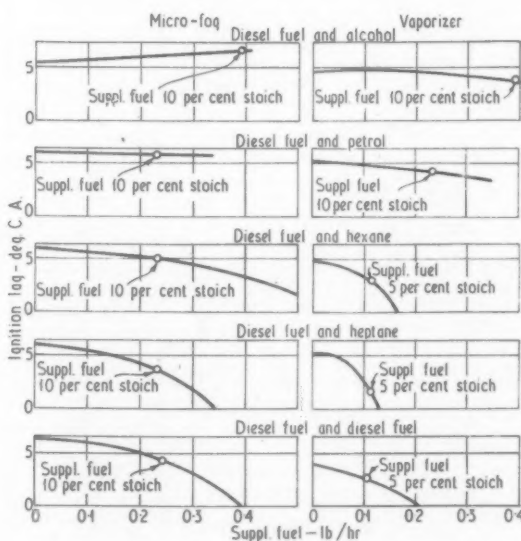


TABLE V. NON-FIRING TEST RESULTS—CFR ENGINE

	Fuel:Air ratio lb/lb	Per cent Stoichiometric	I.m.e.p. lb/in ²	Exhaust temp. deg F	Max. cylinder pressure, lb/in ²
Air alone	0	0	0	120	520
Ethyl alcohol	0.01197	10.8	0.8	120	520
90 octane primary fuel blend	0.00938	14.2	1.7	127	525
44 cetane diesel fuel	0.01072	15.5	7.6	137	565
N-heptane	0.00863	13.1	6.4	150	570
N-hexane	0.01129	17.2	22.0	185	640

No main injection, fuel introduced by Micro-Fog, speed 900 r.p.m., 100 deg F inlet air temperature, 3 zero Hg gauge inlet air pressure

decomposition, the high cetane fuels containing many carbon atoms should be best.

Non-firing tests

In order to gain a better insight into the mechanism of pre-flame reactions, tests were conducted with a non-firing engine. Injection was completely eliminated, and fuel was introduced only into the intake manifold of a CFR engine motored at 900 r.p.m.

With some fuels auto-ignition occurred when the amount of supplementary fuel exceeded a certain quantity, others did not auto-ignite at all. Fig. 21 shows pressure traces with 44 cetane diesel fuel, 90 octane petrol and alcohol, while Fig. 22 shows the same with heptane and hexane. On each, the solid line shows the air compression-expansion line without fuel introduced as a very fine mist. On the hexane and heptane traces the dashed line shows supplementary fuel in the amount which gave the best power output on previous tests with diesel fuel injection, the dotted lines show where incipient ignition set in, and the dash-dotted lines show fully developed spontaneous ignition.

Table V shows the tabulated observations on maximum cylinder pressures, exhaust temperatures and computed i.m.e.p. It shows hexane as being the most effective, alcohol the least effective, with diesel fuel in the middle. This is in marked contradiction to the supplementary fuel tests, which showed diesel fuel as the best and hexane the poorest of those tried, see Figs. 12 and 13.

A significant difference between the two tests was that in the non-firing tests there was no ignition. The shortening of the ignition lag, therefore, could have no part in the process. What obviously played a decisive part was the heat

generated during compression owing to slow oxidation of the manifold-introduced fuel. This caused an amazing rise of pressure and temperature and an appreciable indicated power output, even though most of the heat introduction occurred during the compression stroke.

Inasmuch as in these tests the fuel was introduced in small liquid droplets by Micro-Fog, and oxidation on any appreciable scale can only take place in gaseous state, the fuel had to vaporize before it got oxidized. Therefore, volatility must have played an important part in the process. This would explain the good showing of hexane but fails to explain the poor showing of alcohol. On the other hand, the presence of thermal decomposition during the compression would result in the creation of lighter molecules, some of which would oxidize at a faster rate than the original heavier molecules.

If this speculation is sound, the thermally unstable high cetane fuels should again assume top positions if the volatility factor is eliminated. The first non-firing tests were performed with Micro-Fog and were then repeated with a vaporizer. In this latter case the fuel was in the vapour state when it entered the cylinder and fuel volatility could no longer have an effect. Fig. 23 shows the indicator diagrams obtained under such conditions.

Applications

The study of pre-flame reactions brought closer understanding of auto-ignition. A true understanding of the mechanism through which ignition accelerators work could easily lead to clearer concepts of combustion in both spark and compression ignition engines, including the role of knock suppressing agents. What occurs in a fraction of a

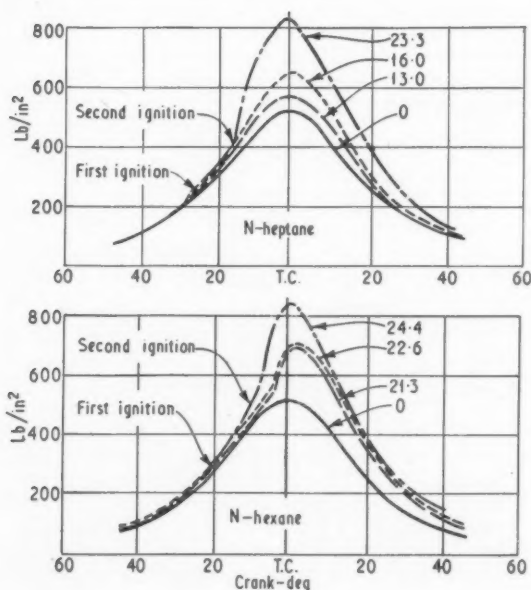
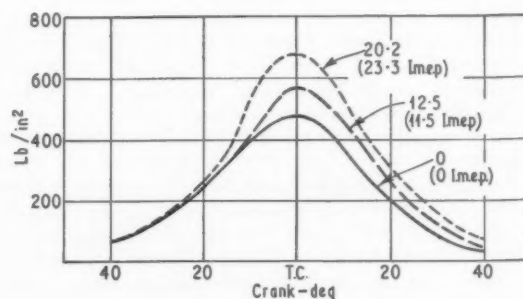


Fig. 22. Left: Non-firing pressure diagrams for n-heptane and n-hexane

Fig. 23. Below: Non-firing pressure diagrams of 52 cetane diesel fuel introduced by vaporizer



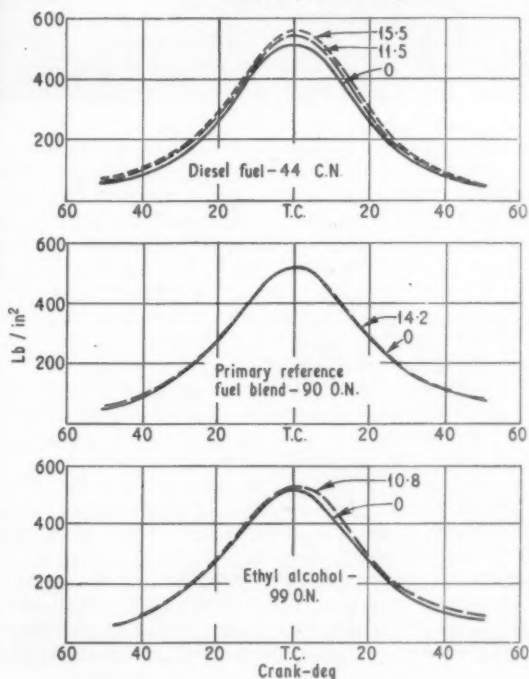
milli-second during normal combustion can, by such technique, be stretched out and studied in steps.

The most obvious use is for reduction of exhaust smoke or increase of smoke-limited power output. Both for convenience and effectiveness it is recommended that the same normal diesel fuel should be used as primary and supplementary fuel. The complication of a two-fuel system is thereby avoided. It is true that a low ignition quality fuel such as petrol, used in quantities of 30 to 40 per cent of the total fuel rate could bring higher power boosts,^{1,2} but intake pipe induction of diesel fuel in such quantities would cause pre-ignition under certain operating conditions and control over the engine would be lost. When the amount of supplementary fuel is restricted to 10-15 per cent of the total, regular diesel fuels are superior to petrol, provided a fine spray is used in both cases.

Apparently, judicious use of the technique would improve the fuel consumption on all types of diesel engines. For best fuel economy it is essential that a mist generator or equivalent is used. If Micro-Fog is used, full-load fuel economy could be improved some 10 per cent; with an ordinary pneumatic spray nozzle the saving will be about 5 per cent.

At present three factors militate against the use of the Norgren Micro-Fog mist generator on commercial engines: cost, bulk, and air consumption. The largest capacity Micro-Fog, the experimental model shown in Fig. 3, has a capacity of 0.2 lb/hr with an air flow rate of 0.4 lb/b.h.p.-hr. At a ratio of 15 per cent, 0.06 lb of supplementary fuel is needed per hour, therefore the device shown is barely adequate for 3½ h.p. An air pressure of 18 lb/in²g is needed to produce this flow which requires 0.26 theoretical horse-power or approximately 0.35 actual horse-power. This means that all the fuel saving would be spent to drive the air compressor to supply the air needed to operate the Micro-Fog. Furthermore, the present Micro-Fog is very bulky. The Micro-Fog is so large and takes so much horse-power because only about 2 per cent of the total amount of atomized liquid is discharged as a mist with drop sizes under 4 microns; the other 98 per cent with larger drop sizes is returned to the tank.

Fig. 21. Non-firing pressure diagrams. The numbers indicate percentage stoichiometric fuel : air ratio



A less extravagant atomizer is the ordinary pneumatic spray nozzle, which also operates with compressed air but uses only about 1/50th as much air per pound of liquid as the Micro-Fog. A 1,000 h.p. engine burns approximately 400 lb of fuel per hour at full load of which approximately 60 lb/hr would be supplementary fuel that would take about 120 pounds of air per hour. The compression of that quantity of air to 50 lb/in²g would absorb about 3.3 h.p., or 0.33 per cent of the engine output.

This technique also makes it possible to use fuels of low ignition quality in compression-ignition engines. High speed diesel engines have difficulty in burning diesel fuels of about 35 cetane number at light load or idle, although operation may be satisfactory at heavier loads. In such cases, the introduction of part of the main fuel as a mist will allow satisfactory operation at all loads.

If the main fuel has still lower ignition quality, for example, motor petrol of approximately 20 C.N., the use of the main fuel as the supplementary will help, but better results are obtained by using a higher cetane fuel doped with a cetane improving additive. The ignition quality of the injected fuel ceases to limit its use in a diesel engine if the supplementary fuel is properly selected. For example, 29 cetane diesel fuel can be satisfactorily used in a small high-speed open chamber engine with a supplementary fuel of 44 C.N. doped with 2½ per cent amyl nitrate.

Diesel engined trucks afford a good field for applying this technique. These vehicles are normally equipped with an air compressor for furnishing compressed air for braking. This equipment should be adequate to supply air to a pneumatic spray nozzle mounted in the intake manifold. A tee in the main fuel line could conduct fuel to the spray nozzle, and the air flow could be controlled by the fuel rack of the injection pump in such a manner that it would begin to operate at around 7/8 load and both air flow and fuel flow would increase with the rack setting up to an acceptable overload. This would enable diesel trucks to climb hills without smoking. Neither the fuel bill nor the maintenance costs would be increased.

References

1. E. J. MCLAUGHLIN, P. L. PINOTTI and H. W. SIGWORTH: "Power Booster Fuels for Diesel Engines," *S.A.E. Journal*, June, 1952, p. 42.
2. L. D. DERRY, E. M. DODDS, E. B. EVANS and D. ROYLE: "The Effect of Auxiliary Fuels on the Smoke-Limited Power Output of Diesel Engines," *Proc. Inst. Mech. Engrs.*, Vol. 168, No. 9, 1954.
3. W. T. LYN: "An Experimental Investigation into the Effect of Fuel Addition to Intake Air on the Performance of a Compression-Ignition Engine," *Proc. Inst. Mech. Engrs.*, Vol. 168, No. 9, 1954.
4. H. A. HAVEMANN, M. R. K. RAO, A. NATARAJAN and T. L. NARASIMHAN: "Alcohol in Diesel Engines," *Automobile Engineer*, June, 1954, pp. 256-62.
5. W. C. ARNOLD, R. H. BEADLE, R. L. LOGELIN and H. D. YOUNG: "Bi-Fuel Approach to Burning Residual Fuels in Diesel Engines," *S.A.E. paper* 42, January, 1947.
6. P. H. SCHWEITZER: "Excess Air and Brake Mean Effective Pressure," *A.S.M.E. Trans.*, Vol. 63, No. 3, April, 1943.
7. J. S. MEURER: "Evaluation of Reaction Kinetics Eliminates Diesel Knock—The M-Combustion System of MAN," *S.A.E. Trans.*, 1956, pp. 250-72.
8. P. H. SCHWEITZER: "A New Concept of Diesel Combustion," *Autom. Ind.*, June 15, 1956.
9. R. O. KING and Others: "Oxidation, Ignition, and Detonation of Fuel Vapors and Gases," *Canadian Journal of Research*, Parts I-XXX, Nov. 1947, Jan. 1948, Feb. 1948, May 1948, June 1948, Sept. 1948, Oct. 1948, Apr. 1949, Sept. 1949, Nov. 1949, May 1950, June 1950, Aug. 1950, Jan. 1951, Feb.-March 1952, Sept. 1952, Jan. 1954, May 1954, 220-241, 1954; 335-347, 1955; 388-407, 1955; 445-469, 1955; 10-20, 1956; 316-334, 1956; 442-454, 1957.

LATHAM SUPERCHARGER

An Axial Flow Unit Designed for Quantity Production Economically with Conventional Tools

ONE of the reasons why superchargers have not been more widely accepted for private cars is that most of them are noisy. The Latham Manufacturing Co., of West Palm Beach, Florida, United States, claim that this objection has been overcome with their axial flow compressor. Hitherto, the development of axial flow compressors has not received as much attention as that of the radial flow type. This is because radial flow superchargers are more suitable for aircraft engines, particularly of the reciprocating piston type, of the radial cylinder-layout, and therefore vast sums of money have been spent by governments on their development for military applications.

The following arguments are advanced by the Latham Manufacturing Co. in support of the axial flow compressor for automobile applications. Although centrifugal compressors are well suited to aircraft engine installations, where the compressor housing and diffuser can be of large diameter, in automobile applications space limitations are such that the diameter must be restricted, and therefore efficiency suffers and speeds have to be high. Reliability tends to be impaired by these high speeds, and acceleration is inevitably sluggish. The need for rapidly accelerating the supercharger drive components sets a number of design problems tending to demand complex drive arrangements. One of the reasons why the radial flow type supercharger is so satisfactory for aircraft applications is that the range of speeds over which these engines are operated for most of their running time is not as great as in automobile applications.

Roots type compressors have been used perhaps more than any others on automobile engines. Their principal disadvantages are the noise they generate and the restricted pressure ratio obtained. Vane type compressors are not so widely favoured, because of the relatively large number of components rubbing against one another and wearing.

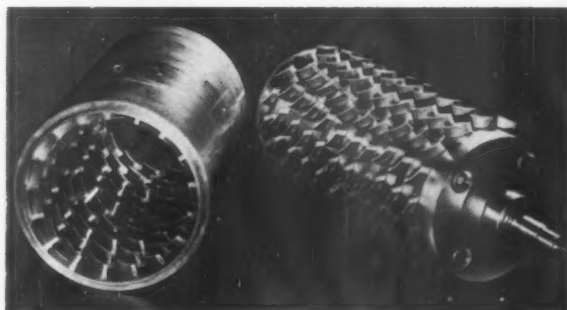
The Latham axial flow compressor has been developed over the last ten years. In producing this design, the manufacturers have sought to fulfil the principal requirements as follows. The unit has been intended, from the outset, for production in large quantities by conventional tools. A range of sizes is available and cost has been kept to a minimum by virtue of an improved method of blade fabrication and attachment. The design is such that a wide range of surge-free operation is obtained. Installation is relatively simple because the unit is of uniform cross section. It is also claimed that with this supercharger, the fuel consumption, over the entire speed range, is improved by an average of 2 m.p.g., as

compared with the standard unblown engine. Another marked advantage of the unit is that it has neither gears and similar moving components subject to wear, nor interlocking rotors that must be accurately synchronized. Its single rotor is carried on two Norman-Hoffmann ball bearings, lubricated through grease nipples.

In this supercharger, the rotor and stator are composed of a series of interlocking blade rings and spacer rings, each of similar cross section and diameter, as shown in Fig. 1. The manufacturers state in their patent specification, that the entire compressor, including the shafts and tie bolts, is made of the same metal, preferably aluminium, to avoid differential rates of thermal expansion. To obtain an annular air passage of constant cross section throughout the length of the compressor, the blade pitch is varied from stage to stage. This can be done without increasing the cost of the blades. A half-tone illustration of the rotor and stator blade assemblies is shown in Fig. 2.

Fabrication and attachment of the blades are effected as

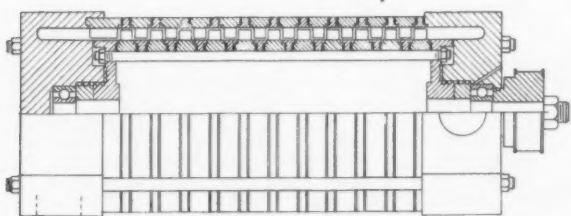
Fig. 2. All the blades on both the rotor and stator assemblies are identical until they reach the manufacturing stage at which final machining of each separate blade and carrier ring assembly is done



follows. They are punched from aluminium alloy sheet of high tensile strength. All the dimensions, except the thickness, of the blanks thus formed are in excess of the finished requirements. These blades are pressed into slots milled in the blade carrier rings. The width of the slots is nominally the same as the thickness of the blades, but the curvature varies from stage to stage. On the other hand, the curvature of the blades as produced by the die is that of the slots in the centre stage; thus, at all the other stages, the blades have to be sprung into their slots.

After the over-size blades have been pressed home, each blade ring and the end faces of its blades are together turned to the finished dimensions. As can be seen from Fig. 3, the finished ring and blade assembly of each stage is of shouldered cross section; and is spigoted into the adjacent T-section spacer rings, the arms of the T-sections fitting over the shoulders of the blades and of the blade rings, which they thus retain. Accurate alignment of the blades is ensured by metal-to-metal abutment between them and the spacer rings. Interposed between the flanks of the spacer rings and the blade rings are gaskets, which are compressed a predetermined amount by the tie bolts that hold the whole

Fig. 1. All the components, including the shafts and tie bolts, of the Latham supercharger are of aluminium alloy. This obviates difficulties with regard to differential rates of thermal expansion



assembly together. The method of attachment of the blades is similar for both the stator and the rotor.

Non-surge operation is obtained over a wide range by virtue of the cross section of the leading edges of the blades. When the flow is considerably restricted, the air tends to approach the blades in the direction of arrow B in Fig. 3, and is therefore approximately in alignment with the leading edge profile. On the other hand, when the compressor is running under its normal operating conditions, the air tends to approach the blades in the direction of arrow A and is therefore approximately in alignment with the blade itself.

For most passenger car installations, a Carter YH sidedraught carburettor is mounted on each side of the supercharger inlet volute, which is at the front. The carburettor throttles are interconnected by a link that passes underneath the stator case. At the rear, the discharge volute is attached, by means of an adaptor, to the standard air intake manifold of the engine to which the supercharger is fitted.

The eleven-stage version of this compressor, which is sold at a retail price of less than 300 dollars, has 363 blades manufactured to a tolerance of 0.001 in. Its outside diameter, over the compressor section, is 6½ in and the distance across the flats of the volutes is 6¼ in. Thus, so far as height is

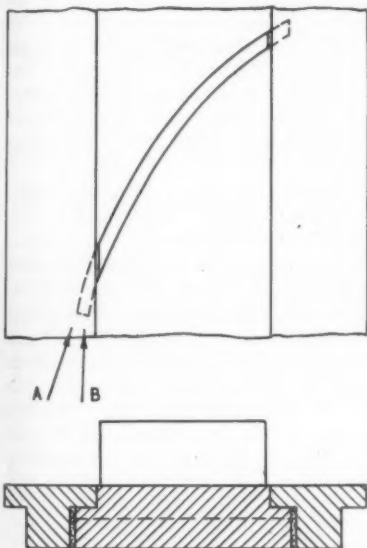


Fig. 3. Detail view showing how the blades are retained in their carrier rings by T-section spacer rings

concerned, the unit compares favourably with the carburettor and air cleaner installations on the majority of American V-eight engines currently in production.

A neat installation of this supercharger on the Ford Mercury L-head engine is shown in Fig. 4. It would appear that the length of the supercharger is not too great for its accommodation above engines of this type. A close-up view of another installation can be seen in Fig. 5.

The manufacturers claim that the most important property of this type of compressor is its high efficiency. Whereas comparable superchargers of other types absorb in the order of 30 b.h.p. at maximum output, delivering at a manifold boost pressure of approximately 3 lb/in², it is stated that under these conditions the Latham unit absorbs only 10 b.h.p. and the manifold boost pressure obtained is 8 lb/in². Because of this, the supercharger can be driven by a 1 in wide, flat belt.

This method of driving the supercharger is claimed to be as effective as it is simple. A large diameter pulley is bolted to the crankshaft pulley. The supercharger drive pulley, on the other hand, is small in diameter. Had a V-belt been employed, the pulley diameters would, of course, have been too large to be practicable for most automobile applications.

A Gilmer belt is employed. It is made up of fine braided



Fig. 4. A Ford Mercury L-head engine fitted with a Latham supercharger used in conjunction with two Carter YH sidedraught carburetors. The throttles are interconnected so that they operate together

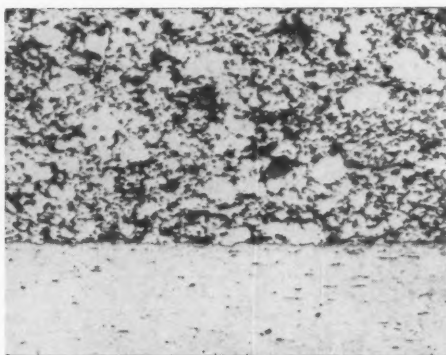
steel wire cables, bonded in turn to a textured nylon facing. A spring-loaded idler pulley is mounted between the drive and the driven pulleys to tension the belt. This belt does not stretch perceptibly, because of its steel reinforcement. Its nylon friction facings are said to be extremely wear-resistant. Another advantage is that since it is only 0.070 in thick, it is very flexible and permits a good degree of wrap-round to be obtained on the small diameter pulley.

Tests have been carried out on a 1956 Ford, overhead valve, V-eight engine, equipped with this supercharger. This engine has a relatively low compression ratio, of 8:1, and therefore is well suited for these tests. The only modification, apart from fitting the supercharger conversion kit to the engine, was an increase in the cylinder diameter to give a running clearance of 0.005 in between the piston and the cylinder. The fuel:air ratio was adjusted to give maximum output.

First the engine was run in its naturally-aspirated condition. In this test, a maximum of 163 b.h.p. was developed at 4,400 r.p.m., and the maximum torque was 235 lb-ft at 3,200 r.p.m. For the second test, the complete Latham supercharger assembly was installed on the engine. This test gave a maximum of 210 b.h.p. at 5,000 r.p.m., and the maximum torque was 282 lb-ft at 3,000 r.p.m. At the speed at which maximum power was developed, the manifold pressure was 6½ lb/in². The increase in horse power obtained by supercharging, as compared with the naturally-aspirated condition, was as much as 72 per cent at 2,000 r.p.m.

Fig. 5. Adaptors, such as those shown in this illustration, can be provided for connecting the discharge volute to the standard air intake manifold of almost any engine currently in production





Photomicrograph of plate section showing the bond between the bronze facing and the steel support plate

SINTERED BRONZE-FACED CLUTCH PLATES

Production of Components for the Borg-Warner Automatic Transmission at Sintered Products Ltd.

A FEATURE of the modern automatic transmission unit is the compact, multi-plate clutch running in oil. As more makes of cars are being equipped with automatic transmissions and as more vehicles so equipped are going into service, the numbers of clutch plates required will rapidly increase. Already the figures are substantial and should the use of automatic transmissions become more or less general, as in the U.S.A., the quantities will assume significant proportions. An indication of this was given in a recent article* on barrel finishing, in which was described an automatic plant operated by one American concern for processing 3,200 clutch plates per hour.

For the automatic transmission unit manufactured by Borg-Warner Ltd., Letchworth, Herts., the clutch plates are produced, faced, and finished for Borg-Warner Ltd. by Sintered Products Ltd., Hamilton Road, Sutton-in-Ashfield, Notts. This company manufactures a number of grades of sintered bronze or iron friction material, variously suitable for a wide range of both wet and dry applications. These materials, designated S1, S2, S3, *et seq.*, are marketed under the trade name of "Don" by Small and Parkes Ltd., Hendham Vale Works, Manchester 9. The composition and the operating characteristics of each of four of these materials, together with

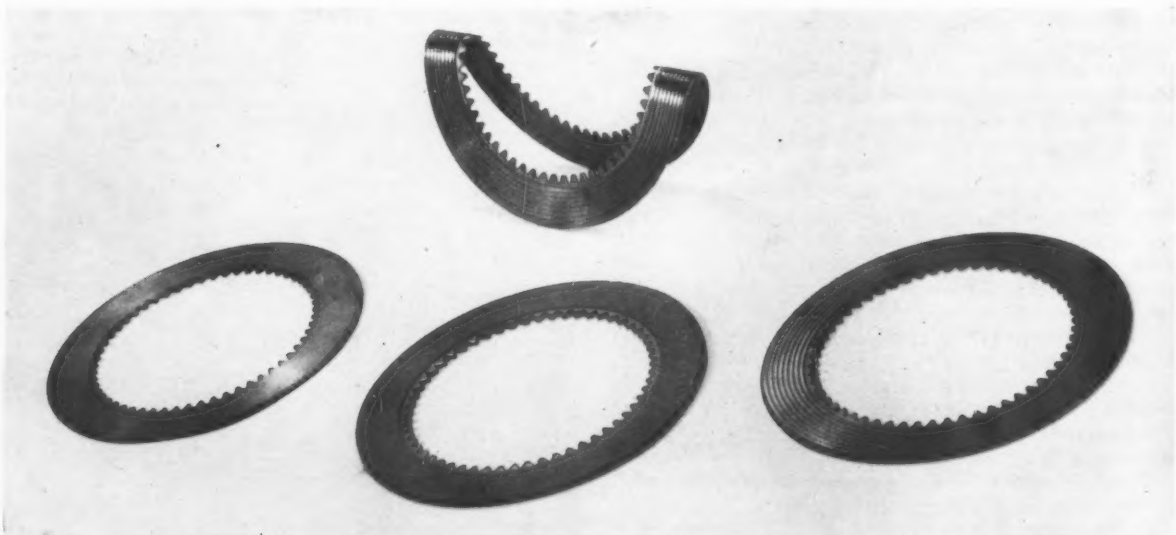
the method of production, have been fully described in this journal†.

The material used for the Borg-Warner plates is the S3 grade, which is specifically intended for wet applications where high static and dynamic friction coefficients are required. Under static conditions the coefficient is 0.13 to 0.15 at a pressure of 20 lb/in². Curves plotting the dynamic coefficients, determined in a test run in oil at various application pressures and rubbing speeds, are given in the graph. As regards composition the main constituent is copper, but small percentages of lead, graphite, silica, iron, and other ingredients are included.

On a clutch incorporated in an automatic transmission there is little scope for such practices as "bedding down" or "wearing in", and consequently the plates must be manufactured to what may be regarded as relatively close tolerances and a comprehensive inspection system be employed to ensure conformity in the finished component. The facing rings are produced individually on a hydraulic compacting press at a pressure of nominally 12.5 ton/in² to a thickness of 0.22-0.24 in. Obviously, a ring approximately 5 $\frac{1}{8}$ in external diameter and 3 $\frac{1}{8}$ in internal diameter of such a thin section requires very careful handling while in the "green" state. After the stripping of the dies and ejection, the compact is slid onto a flat sheet metal plate and on this

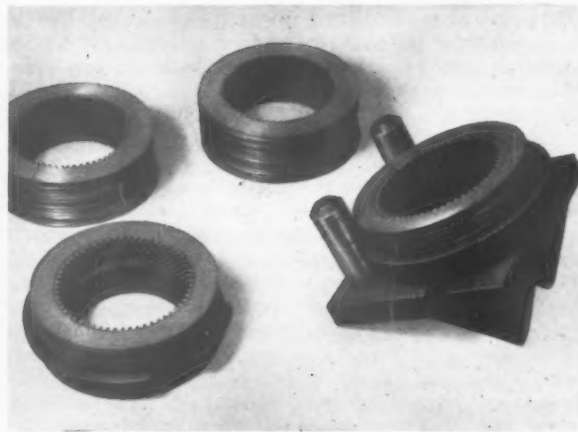
*"Automobile Engineer", October 1957
†"Automobile Engineer", July 1955

Copper-plated steel support plate, the composite plate as it leaves the sintering furnace, and the machined and ground finished plate. A test specimen folded through 180 deg illustrates the effectiveness of the bond between the friction rings and the support plate





Compacted facing ring ejected from the press tools



Assembly of components on stacking fixture prior to sintering

is removed from the press table and stacked on a tray ready for assembly.

Fully annealed steel to En 32 or S3 specification is used for the steel support plates, with En 6, En 8, or En 12 steels as permissible alternatives in the event of supply difficulties. The sheet material is 0.33 ± 0.002 in thick and the surfaces must be free of rolling scale. It is pierced and blanked, with 0.004 in and 0.005 in tolerance on the internal and external diameters respectively. The bore of the plate is blanked to form 57 teeth of 16 diametral pitch, the pitch circle diameter being 3.5625 in. Check dimension for these teeth is 3.478-3.4835 in between 0.090 in diameter pins.

All burrs are removed and the plate must be parallel within 0.002 in and flat within 0.005 in. After chemical cleaning the plates are then copper plated. The copper coating protects the surfaces of the plate from oxidation during sintering and also facilitates the formation of a metallurgical bond between the plate and the friction material.

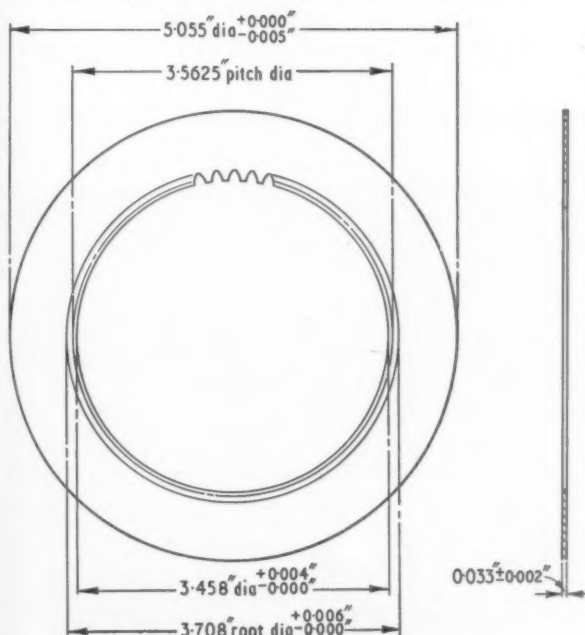
A photomicrograph of a sectioned plate, giving some indication of the intimate character of the bond between the

sintered bronze facing ring and the steel support plate, appears at the head of this article. On the same page, the effectiveness of the bond is shown in the photograph of a test plate bent through 180° . Although the facing rings are locally cracked there is no evidence of lifting and no particles are detached.

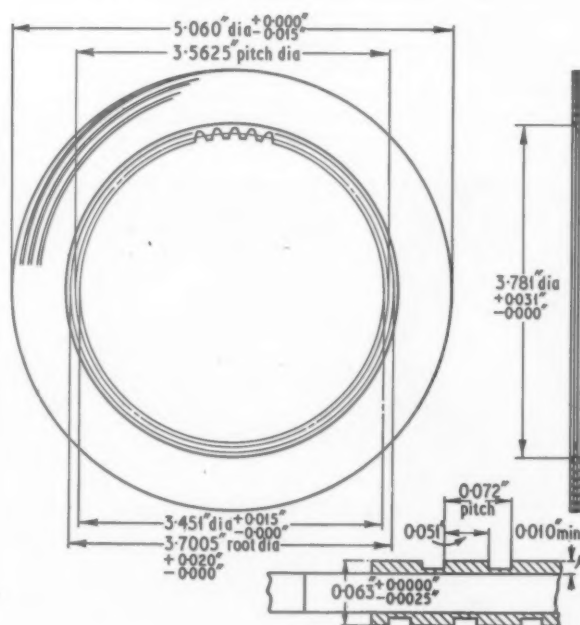
Support plates and compacted facing rings are assembled in stacks on an inclined plane fixture, the component items aligning concentrically by the engagement of their peripheries with two perpendicular pins. Individual assemblies are separated by a carbonaceous compound to ensure parting after sintering.

From ten to twenty assemblies are stacked on a ring, of graphite or of "Thermex" heat-resisting steel, which provides a convenient method of handling and serves as a spacer when they are loaded in the sintering furnace. These furnaces are of the bell type and are electrically heated. Multiple stacks of assembled parts on their spacer rings are built up on the furnace base, with a total of 400 to 500 assemblies constituting a charge. Pressure to a value between 10 and

Copper-plated support plate in En 32 steel



Finish ground friction plate, faced with Don S3 material



250 lb/in² on the projected ring areas of the six stacks is applied to keep the plates flat and also to ensure the friction material rings bond satisfactorily to their support plate. This pressure is provided by the weight of the furnace bell, or by an air pressure cylinder operating through a lever and a central bar.

The assemblies are sintered in a protective atmosphere, confined in an atmosphere can that encloses the charge and is sealed at the base. Over this is placed the external furnace bell with the heating elements and the refractories mounted in the walls. To sinter, the charge is brought up to the appropriate temperature of 760-800 deg C and held at that value for 30 minutes. The overall time cycle for this operation, including loading and unloading the furnace, is between 3 and 6 hours, determined according to the weight of the charge. A furnace unit comprises a heating bell and a plurality of bases and atmosphere cans. The heating bell is removed at the termination of the critical temperature period and transferred to another base already loaded and ready for operation. During the cooling phase the atmosphere can remains in position until the temperature of the charge has fallen to a value precluding the possibility of oxidation.

During the sintering process the combination of heat and compressive pressure occasions some slight displacement of the material of the component parts. Allowance is made for this effect, of course, in the dimensions of the parts as initially produced. From the drawings of the support plate and the composite plate it will be noted that the nominal internal diameter, over the addenda of the teeth, is reduced from 3.458 in to 3.451 in. The tooth measurement over 0.090 in diameter pins is also reduced from 3.478-3.4835 in to 3.4738-3.481 in.

The composite rings are machined on both friction surfaces and on the outside diameter. This operation is performed on a cam automatic; the plate being set up on the profiled spigot of a magnetic face plate on the spindle. A front form tool mounted on the main slide faces the friction surface, removing about 0.005 in, and simultaneously cuts in it the scroll-type oil groove. In section the groove is rectangular, 0.021 in wide and 0.006 to 0.009 in deep, and is formed with sharp corners. It is machined as a single-start spiral, running from the inside diameter to the outside diameter, with a pitch of 0.072 in and leaving a land 0.051 in wide. The surface is continuously brushed to clean the grooves as they are turned and, since the facing material contains finely divided lead and silica, dust extraction



Assembled plates stacked on the base of the sintering furnace

equipment is fitted. A tool mounted on the back slide machines the outside diameter.

On completion, the plate is unloaded, reversed, replaced on the face plate, and the operation is repeated on the other face. The feed stroke of the form tool is automatically increased to compensate for the reduction in thickness of the work by the first operation and to size the work. When both facings are machined the overall thickness is 0.68 in and the minimum acceptable thickness of either facing is 0.010 in. No change is made in the hand of the scrolling when the plate is reversed, so when assembled in the clutch unit the scrolls on the contiguous surfaces of adjacent plates are of opposite hand. Since the grooves serve mainly as escape routes for oil when the clutch is engaged, this feature is of no operational consequence.

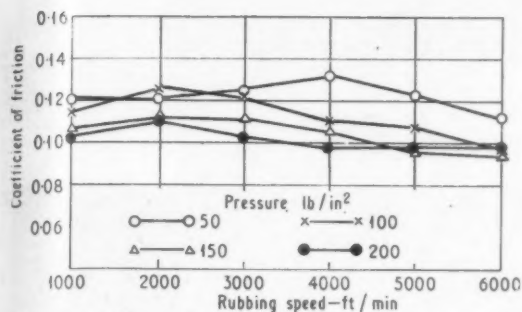
After machining, the plates are ground on each surface

Set-up for facing friction ring, machining scroll oil groove and turning outside diameter



Finish grinding the plates on machine equipped with 6-station indexing table





Coefficient of friction of S3 friction material at different pressures and rubbing speeds

to reduce the overall thickness from 0.068 in to 0.063-0.0605 in. The operation is performed on a horizontal grinding machine with a similar set-up to that used for

finishing piston rings. Plates are loaded onto and unloaded from a 6-station rotatable table which is automatically indexed by an air-operated ratchet mechanism. As a plate reaches the grinding station it is transferred to a rotating magnetic face plate. The grinding head then strokes; the wheel moving radially across the friction facing and then returning. Production rate exceeds 400 plates per hour. The operation is repeated with the plate reversed to finish the other facing.

Inspection is arranged to provide a comprehensive check on accuracy and a practical guarantee of consistency in performance. There is a 100 per cent visual examination and a check on parallelism. A 20 per cent check is made on outside diameter; inside diameter, over pins; thickness; flatness, by passing through spaced plane surfaces; and the tooth circular space, by an expanding rig and a dial gauge. The depth of the scroll groove is also checked on 10 per cent of the plates.

The Numericord Data-Control System for Machine Tools

IN 1952 Giddings and Lewis Machine Tool Co., Fond du Lac, Wisconsin, U.S.A., sponsored a research at the Massachusetts Institute of Technology for the design and development of a director that could produce control information to operate a multi-axis machine tool system. The data-control system developed as a result of this work is known as the Numericord system. This system has four distinct operational phases: the preparation of the mathematical data; the checking and transcription of this data on to punched paper tape; the relating of this data to time, including the carrying out of linear interpolation; and finally automatic operation of the machine tool.

Preparation of the mathematical data is usually referred to as programming. It is the only technical function involved. The programme engineer receives a drawing of the part to be machined, decides what cutters are to be used, what fixtures are necessary, and specifies all other related machining conditions such as feed rates. He also decides the sequence in which the individual faces of the part shall be machined; this is specified by entering on a programme sheet the co-ordinates of points through which the cutter is to pass. The arithmetical calculations entailed can be effected on an electronic digital-computer or, for simpler shapes, on a standard electric desk calculator. The completed programme sheet is passed to a copy-typist who operates the keyboard of a transcription unit. This unit checks the logic of the information on the sheet, and if the logic is correct, transcribes it as a series of punched holes in a paper tape.

The director

The punched paper tape is used to enter data into the director, the next stage of the preparation system. Data are entered on the tape in blocks, and each block contains the incremental displacements required of the machine slides along each axis, together with the time over which this motion is to take place. The director then produces synchronized control-information that ensures the cutter will move along a straight line between its initial point and a new point implied by the displacement values quoted for each axis. Straight-line interpolation is not limited to particular planes bounded by the principal axes of the machine tool. It can also be carried out in skew planes where x , y and z incremental displacements are given. In the director, the control information is also related to time to give the correct cutter feed rate. The continuous control-information so derived is then recorded on magnetic tape.

Magnetic tape

The magnetic tape is 1 in wide and 0.04 in thick. There are 14 recording tracks spaced across its width. The allocation of these tracks may differ from machine to machine, depending upon the application, but certain specific functions are controlled by signals recorded on specific tracks. For identification, the tracks are numbered from 1 to 14, numbering starting from one edge and continuing in sequence across the width.

On one of the middle tracks (track 7) a 200 cyc/sec reference signal is recorded. On the five tracks adjacent to it (tracks 5, 6, 8, 9, 10) are recorded square-wave signals for controlling the motion of five machine-tool slides. These tracks are allocated in this manner so that should the magnetic tape be slightly misaligned under the reading heads—slightly askew for example—phase accuracy between the important signals that control slide movements will scarcely be affected. Tracks 4 and 11 are used for controlling the magnetic tape transport mechanism.

Signals that operate on-off auxiliary functions such as supply of coolant, control of spindle drive and operation of clamps are recorded on the six remaining tracks. The control information operating auxiliary functions is impressed on the magnetic tape as sinusoidal signals of either 200 cyc/sec or, 4,000 cyc/sec frequency. The appropriate auxiliary function will be switched on and will remain on as long as the particular signal-frequency that is used to operate it is impressed on the tape. For example, the coolant will be supplied as soon as a 200 cyc/sec signal is detected on track 1, and will remain on as long as the signal is recorded on this particular track. A 4,000 cyc/sec signal on track 1 will, however, initiate operation of a side clamp.

Therefore, although only six tracks are provided for auxiliary functions, 12 auxiliary functions can be controlled by allocating a different frequency and track to each. Two signals of different frequencies can be recorded simultaneously on the same track, and can be separated for identification by high-frequency and low-frequency filters in the control circuit. Track 4 has the playback stop for stopping the machine tool completely, while track 11 has planned stops for stopping the machine at the operator's discretion. The Numericord system and applications are described in full detail in the January, 1958, issue of our associated journal *Aircraft Production*, in one of a series of articles based on information collected by the author during a visit made specifically to investigate the latest practices and probable developments in the United States of America.

Balancing Engines

A Ford Development in America

BALANCING engines dynamically is not a new process in the U.S.A. Lincoln and Mercury engines for example have been balanced in this way since 1954 by using large, stationary, electrically driven machines. This method, however, required handling all engines regardless of whether they needed balancing or not. With statistical quality control, the majority of engines do not require balancing, but it has been necessary to check them all on special machines to find out which are in tolerance and which are out. As a result, considerable time has been lost.

In a new process, developed by the Ford Motor Company, which combines balancing with hot testing so that it becomes part of the regular cycle, this unnecessary handling is eliminated. The percentage of engines that need balancing at this point is still only a fraction of the total so the majority are checked in balance while being hot tested and are then passed on. The new process not only saves time but reduces floor space requirements. In addition the equipment has a production capability of $\frac{1}{2}$ oz-in with a linear response of $\frac{1}{8}$ oz-in throughout the range. This is especially advantageous when weight slugs are used. Another advantage is that without external couplings to drive the engine there is no external source of unbalance added to the engines under test.

In the Ford plant, a conveyor automatically delivers engines to the hot test area where each stand is equipped with an electronic balancer built by International Research and Development Corp., of Columbus, Ohio. The principal components of a balancer are two vibration pick-ups, a console containing amplifiers, filters and associated electronic circuitry, two meters for indicating the amount of unbalance, and a stroboscopic unit that indicates both engine speed and location of unbalance.

The two vibration pick-ups are the sensing elements for vibration caused by unbalance and are mounted on an arm attached to the conveyor carrier. One pick-up points radially to the front and the other radially to the rear correction plane of the engine. The front correction plane is on the V-belt pulley and the rear correction plane on the flywheel. Alternating currents generated by the pick-ups respond to the mechanical motion of the engine and are proportional to the vibration amplitude and r.p.m. of the engine. The phase of the electrical output bears an established relationship to the physical location of unbalance.

Output from the pick-ups is fed to the console which houses the electrical equipment that operates the system. In addition to the dual channel circuitry for simultaneous treatment of signals from both the front and rear pick-ups, the console contains a dual calibration system controlled by one master selector switch to accommodate different types of engines. Each electronic channel contains filters, amplifiers, integrating circuits, and plane separation networks. The purpose of the filters is to reject all unwanted vibration signals—explosion pulses, reciprocating pulses, vibration from outside the engine, etc.—except vibrations resulting from the engine's rotational speed of 1,500 r.p.m. The plane separation network eliminates the effect of unbalance at one end of the engine upon the reading at the opposite end.

Signals from the console are fed to two meters mounted above each test. These meters simultaneously present the amount of unbalance at the front and rear of the engine. In addition to direct calibration in ounce-inches, each meter is graduated into four major divisions coloured green to indicate the acceptance tolerance, and yellow, orange and red, to indicate the size weight to be added.



Every engine produced by Ford Motor Company of America is tested for dynamic balance

Other signals to indicate engine speed and the position of unbalance at the front and rear of the engine are fed from the console to a stroboscopic unit mounted by the front engine pulley. This unit contains two stroboscopic lights—one triggered by a 1,500 c/min oscillator and the other by each vibration unbalance sensed by the pick-up.

A reference mark is placed on the accessory sheave before the engine enters the hot test area. After an engine has been connected on the hot test stand, the operator attaches the support arm containing the pick-ups to the conveyor carrier and the engine is throttled to 1,500 r.p.m. as indicated by the stroboscopic light. The operator then reads the meter, and if the unbalance does not exceed tolerance, no further work is required. If the unbalance does exceed tolerance at either the front, rear, or both, he engages the first light in the stroboscopic unit to observe the position of unbalance at the front and rear.

The engine is stopped and rotated manually to position the mark at the location observed under the stroboscopic light while the engine was running. An air tool is then employed to quickly drive a weight of proper size into pre-drilled holes in the flywheel or the front pulley—the size being indicated by the meters and the location by the stroboscopic light.

Correction

IN the 1957 Show Review issue of this journal reference was made, in the section dealing with "Brakes," to the Feeny and Johnson self-releasing, self-sealing, breakaway coupling for connecting the vacuum hoses of caravan or trailer brakes to the brake system of the tractor vehicle. In the same section there is an illustration of the Feeny and Johnson S.B.S. valve which is fitted on the trailer. Unfortunately, the wording of the caption to this illustration suggests that the breakaway coupling, and not the S.B.S. valve, is shown.

Recent Foreign Publications

Brief Reviews of Current Technical Books

Entwicklung von Verfahren und Geräten zur Prüfung Lichttechnischer Einrichtungen an Kraftfahrzeugen sowie Untersuchungen zur Ergänzung der bestehenden Prüfvorschriften (Development of Procedures and Equipment for the Testing of Lamps and Illuminated Signals for Motor Vehicles, and also Research leading to the Completion of Test Specifications.)

In German. By Dr. Heinz Behrens

Düsseldorf: VDI-VERLAG G.M.B.H., 1957. 8½ × 11½. 30 pp. Price DM 13.50.

In this work, a series of lamp and signalling installations for motor vehicles and for use on the road is studied from the design point of view. As a result of this work, existing specifications to ensure efficient operation have been completed. The author states that for side lamps, an intensity of 0.5 candles is considered to be sufficient, since it cannot be distinguished from the dimmed headlamps from an adequate distance. For red tail lamps, the earlier specification of 0.2 candles appears to be too low. A value of certainly not less than 1 candle should be used. Red stop lamps should shine more intensely than the tail lamps, and even at values of 8 to 12 times that used for tail lamps, stop lamps are not adequate for all traffic conditions. Better results were obtained with a minimum light intensity of 50 candles for stop lamps and 10 candles for tail lamps.

In the report, it is suggested that there is no need to lay down a minimum size of tail lamp glass. It is stated that the checking of a tail lamp by comparing it with a standard form of lamp is unreliable and at the best can only serve as a means of deciding whether exact photometric measurements should be carried out.

Further investigations into usefulness and efficiency have been carried out on various warning devices, both for use on vehicles and to mark obstructions and danger points on roads. In the report, it is stated that flashing lamps are most effective as a warning device. The efficiency of reflectors can be assessed generally by the quality of the reflecting device. Their effectiveness as road signals undoubtedly is increased by placing several signals, adequate distances apart, ahead of the source of danger.

Hitherto, the effectiveness of number plate illumination lamps has been judged by the minimum brightness of the darkest spot and the brightness ratio between the brightest and darkest spots on the number plate. The distribution of brightness on the plate is of prime importance. A relative appraisal of this might be possible by the indication of either a brightness ratio between two adjacent points or a brightness gradient. However, at present, there is not sufficient test material available for a proper evaluation in this respect.

Untersuchungen über Mehrkreisige Druckmittelbremsen für Kraftfahrzeuge (Investigations of Multi-Circuit Pressure Actuated Brakes for Road Vehicles). Deutsche Kraftfahrzeugforschung No. 102.

In German. By Hans Liebold, Dipl.-Ing.

Düsseldorf: VDI-VERLAG G.M.B.H. 1957. 11½ × 8½. 31 pp. Price DM 13.90.

While pneumatic or hydraulic servo-actuated brakes have been developed to a high level of performance and reliability, their fundamental weakness is that, in case of damage of the supply line to a single wheel, the whole system might in certain circumstances become ineffective. The independent brake system usually provided in addition to the power-assisted brake is generally designed for parking only and, in any case, valuable time is lost before the driver can make use of it in an emergency. Because of this, the possibility of dividing the power brake into independent circuits to the different wheels has been considered from time to time. The monograph under review, No. 102 of the VDI series, covers an investigation to determine whether the development of such circuits should be fostered and, if so, how they should be arranged to obtain best results. As mentioned by the author, one

of the earliest papers on this subject, by Bradley and Wood, was published in the January 1931 issue of *Automobile Engineer*.

In common with most other investigations of this type, the starting point is an assessment of the present state of development, coupled with a summary of operating experience with single and multi-circuit brake systems. Following this, the author briefly deals with the results of tests carried out with a lorry weighing 5.2 ton, laden. The tests were carried out as follows: with all wheels braked; front wheels braked; rear wheels braked; front left and rear right wheel braked; front right and rear left wheel braked; right front brake cut out of operation; left rear brake cut out of operation; and right rear brake cut out. To ascertain the effect of handed braking, the load was biased to one side.

Since tests of this nature are of general value only when correlated with and strengthened by theoretical considerations, the author considers the theoretical aspects of biased braking with particular reference to the steering and road-holding properties of the vehicle. This part of the work occupies the major portion of the monograph, and is also its most important and interesting part. It culminates in an example of the practical application of the theory worked out in considerable detail. The conclusions suggest that the adoption of multi-circuit brakes is to be favoured, and the monograph ends with an outline of requirements that should be met to ensure satisfactory performance. In common with previous papers, on the subject of vehicle braking, which have emanated from Prof. O. Bode's Road Vehicles Institute, at the Technical High School at Hanover, this publication is of a high standard and provides a wealth of valuable and thought-provoking information of considerable value to vehicle and brake designers.

Versuche an Zügen mit Selbsttätiger Lastanpassung der Anhängbremsen zur Ermittlung von Kenwerten für die Unmittenbare Bremsprüfung (Tests with Trains with Automatic Load Adjustment of Trailer Brakes to Determine the Characteristics of Direct Brake Tests). Deutsche Kraftfahrzeugforschung No. 101.

In German. By Prof. Dr. Otto Bode and Dipl.-Ing. Hans Liebold. Düsseldorf: VDI-VERLAG G.M.B.H. 1957. 11½ × 8½. 21 pp. Price DM 12.50.

This monograph is No. 101 of the road vehicle research series published by the German Society of Engineers. It deals with further work carried out at the Technical High School at Hanover on the subject of lorry and trailer brakes, previous work being reported in monographs Nos. 87, 89 and 97. According to the previous investigations, the determination of retardation alone is insufficient for the assessment of the function of a brake; more thorough methods are required to obtain better evaluation. Among these methods is the continuous recording of brake action, as well as of forces in the drawbar between the lorry and the trailer.

The latest report deals with the results of tests carried out with some of the more modern brake systems. In it, the authors consider the possibilities and difficulties of ensuring automatic regulation of the brake action, to suit the load requirements, with different brake types, such as air, hydraulic and inertia, or drawbar, types. They also discuss the requirements that must be met to ensure satisfactory operation. Extensive tests were carried out using a lorry weighing about 7 ton, fully laden, towing a 9 ton fully laden trailer. The trailer was tested equipped with, in turn, conventional pneumatic brakes, load-adjusted pneumatic brakes, hydraulic brakes, and drawbar-controlled pneumatic brakes. All the test results were evaluated in terms of lorry, trailer and train performance. In addition, the shock encountered at the drawbar was determined as a function of the time interval between the start of brake pressure build-up and the attainment of full brake pressure. The magnitude of the maximum brake pressure was expressed as a function of the time required for brake application and of half the time for pressure build-up. Finally, suggestions are made for the testing of trailer brakes with automatic devices for their adjustment relative to the load carried.

In this latest VDI monograph, the high standards of the earlier issues are maintained. The work should be of particular interest and value to vehicle and brake designers, as well as to supervising authorities responsible for brake testing. It is well produced, and the numerous diagrams should be intelligible to engineers, even if they are not familiar with technical German. However, the actual subject matter covers only 15 pages, so the price works out at about 1s 3d per page, which is rather high.

Teoria, Konstrukcia, Raschet i Ispitanie Dvigateli Vnutrenego Sgorania (Theory, Design, Calculation and Testing of Internal Combustion Engines).

In Russian

Moscow: PUBLICATIONS OF THE ACADEMY OF SCIENCE. 1957. 10 x 6½. 201 pp. Price 11 roub 90 kop (10s).

The work under review is the third volume of research reports published by the Internal Combustion Engine Laboratory of the Russian Academy of Science. It opens with an eight page article, by Stechkin, Mihailov and Sviridov, commemorating the eightieth anniversary of Prof. Nicolai Romanovich Briling, head of the reciprocating engine division of the laboratory. Briling, whose teaching and design work dates back to 1907, and who, in conjunction with V. I. Grinevetski is regarded as the originator of Russian compression ignition engine design and research, was responsible for the design and development of numerous engines mainly for transport applications and with outputs of up to 3,800 b.h.p. He has published numerous papers and several good text books, and his standing in Russia is equivalent to that of Sir Harry Ricardo in this country.

The first paper, by N. R. Briling, which occupies 30 pages, deals with the theory of the short-stroke diesel engine. In it, the author considers engines with stroke : bore ratios from 1.2 : 1, which is regarded as normal, to 0.8 : 1. First, he discusses the heat transfer problems to the coolant, then the starting characteristics, the peculiarities of the combustion process of the short-stroke engine, the effect of speed on cylinder charge, the effect of speed on inertia forces and dynamic loads, and the effect of stroke : bore ratio on thermal stresses and the specific output. This work is, perhaps, the most thorough and rigorous investigation so far published on this topical subject, and it is backed by some experimental results. From it, the author draws the following conclusions:

1. Reduction of the stroke : bore ratio increases the specific output and reduces specific weight. Thus, if for a conventional engine the specific weight amounts of 5.7 kg/b.h.p., then, for a short-stroke engine, it can be reduced to about 4.5 kg/b.h.p.
2. Similarly, a reduction of the stroke : bore ratio is of advantage

for automobile engines, since it reduces the overall height.

3. The reduction of stroke : bore ratios is of particular benefit so far as the crankshaft rigidity and bearing reliability are concerned: increased crankshaft rigidity, and the resultant reduction in deflection, leads to improved lubrication. Thus, it is concluded that reduction of the stroke : bore ratio substantially improves engine design parameters.

Investigations of the flow conditions in gas turbine combustion chambers are dealt with in 20 pages by Prof. A. I. Mihailov. The theoretical aspects of the flow distribution are considered, together with an appreciable amount of experimental evidence. A method based on these considerations, is suggested for the calculation of the flow velocity distribution at various points of the chamber. This method is also suitable for the calculation of temperature and fuel density distribution.

The theoretical considerations and experimental data relating to the determination of the specific heat of technical gases are dealt with in 18 pages by M. D. Apashev, with particular reference to the equations published in 1939 and 1948 by Vukalovich and Novikov. Next, the effects of combustion process parameters on the indicator diagram are considered by Y. B. Svidorov. This paper, which occupies 22 pages, discusses the subject with particular reference to the propagation velocity, its effect on pressure rise and the effect of that rise on the indicator diagram and the cycle efficiency. In conclusion, a practical example is fully worked out.

An eight page paper, by A. V. Rachinsky, discusses the effect of fuel in the charge of carburettor engines on both the flow into the cylinders and volumetric efficiency. Then, in a paper that covers 38 pages, K. A. Sharpov considers, mainly against the background of American engine data, the possibilities of standardizing transport engines. A short paper, nine pages, by B. S. Stechin and M. D. Apashev, deals with tests carried out to ascertain simultaneously the flame propagation and pressure changes in a spark ignition engine. The thermodynamic analysis of the engine combustion process is dealt with in some detail, in 30 pages, by Y. B. Svidorov. He limits his investigations to the determination of the relationships between burnt mass and volume, and the rise of pressure and the propagation of burnt charge, as well as the plot of temperature distribution in the charge at any given moment during combustion. This paper concludes with a worked out example illustrating the proposed method. Finally, a 12 page paper by A. P. Lebedinski deals with road tests of vehicles, with particular reference to towed-load trials, the load being provided by a second car of a type similar to that on test.

This most interesting collection of papers is of value to engine research workers. Prof. Briling's paper is particularly welcome, because of its clarification of the main aspects of the stroke : bore ratio problem and its influence on internal combustion engine design.

BOOKS of interest to AUTOMOBILE ENGINEERS

AUTOMOBILE CHASSIS DESIGN

By R. Dean-Averns. 2nd Ed. 30s. net. By post 31s. 4d.

AUTOMOBILE EFFICIENCY

Maintaining Performance with Electrical Test Equipment. By E. T. Lawson Helme, A.M.A.E.T. A.M.I.M.I. 10s. 6d. net. By post 11s. 3d.

AUTOMOBILE ELECTRICAL EQUIPMENT

By A. P. Young O.B.E., M.I.E.E., M.I.Mech.E. and L. Griffiths, M.I.Mech.E., A.M.I.E.E. 5th Ed. 25s. net. By post 26s. 5d.

DIESEL MAINTENANCE

A Practical Guide to the Servicing of the Modern Automotive Diesel Engine. By T. H. Parkinson, M.I.Mech.E. Edited by Donald H. Smith, M.I.Mech.E. 4th Ed. 12s. 6d. net. By post 13s. 6d.

ELECTRICAL SERVICING OF THE MOTOR VEHICLE

Principles, Design and Choice of Test Apparatus. By E. T. Lawson Helme, A.M.A.E.T., A.M.I.M.I. 8s. 6d. net. By post 9s. 4d.

GAS TURBINES AND JET PROPULSION

By G. Geoffrey Smith, M.B.E., Revised by F. C. Sheffield. 6th Ed. 35s. net. By post 36s. 9d.

THE MODERN DIESEL

Automotive Oil Engines for Transport, Marine and Industrial Use. By Donald H. Smith, M.I.Mech.E. 12th Ed. 12s. 6d. net. By post 13s. 7d.

THE MOTOR TRADE

A Guide to Selling, Servicing and Management. By H. E. Milburn, M.I.Mech.E. 21s. net. By post 22s. 1d.

SERVICING GUIDE TO BRITISH MOTOR VEHICLES, CARS, COMMERCIAL VEHICLES AND TRACTORS. Vol. 1.

63s. net. By post 66s.

SERVICING GUIDE TO BRITISH MOTOR VEHICLES, CARS, COMMERCIAL VEHICLES AND TRACTORS. Vol. 2.

42s. net. By post 44s. 6d.

SERVICING GUIDE TO BRITISH MOTOR VEHICLES, CARS, COMMERCIAL VEHICLES AND TRACTORS. Vol. 3.

50s. net. By post 52s. 6d.

SERVICING GUIDE TO BRITISH MOTOR VEHICLES, CARS, COMMERCIAL VEHICLES AND TRACTORS. Vol. 4.

57s. 6d. net. By post 60s.

Obtainable at all booksellers or from : **ILIFFE & SONS LTD., Dorset House, Stamford St., London, S.E.1.**

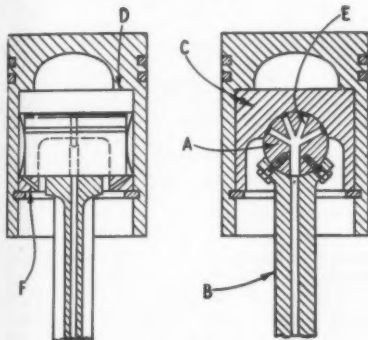
CURRENT PATENTS

A REVIEW OF RECENT AUTOMOBILE SPECIFICATIONS

Piston and connecting rod assembly

Gudgeon pin bearings in high performance engines are highly stressed mechanically and thermally and are of relatively restricted area. The attendant problems are largely met by the use of high-quality bearing materials and meticulous accuracy in machining and assembly. This design, intended particularly for two-stroke engines of the fuel-injection type, aims to provide a long-life, plain bearing using only a cheap bearing material.

The pin A is seated directly in the radiused end of the connecting rod B and secured by radially positioned set screws. An uninterrupted plain bearing for the pin is provided in a seating C of a suitable aluminium alloy. The seating, recessed on the underside to clear the connecting rod,



No. 769352

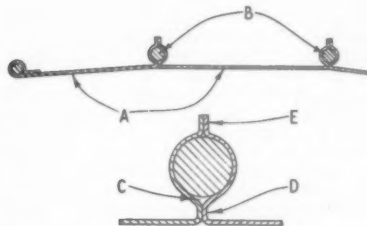
is cylindrical in shape and is fitted into the piston to abut a shoulder D. A spring ring retains it in its assembled position.

Lubricating oil is fed to the bearing by way of the drilled connecting rod and radial ducts E in the pin. Grooves for the distribution of the oil are machined longitudinally in the surface of the pin. On each side of the seating drillings F are provided for the return of oil to the sump. Patent No. 769352. Klöckner-Humboldt-Deutz A.G. (Germany).

Head lining

It is known to produce a head lining for a vehicle by sewing together strips of lining material with at least two rows of stitching suitably spaced apart to define a transverse pocket through which a listing rod can be passed. The invention provides an improved method of construction on those lines.

The lining is built up from a number of shaped strips A of a material comprising a textile base coated with polyvinyl chloride. It is secured in position in the vehicle by means of listing rods B passing through pockets C. To form these pockets, marginal portions of adjacent strips are folded upwardly so that the coated surfaces are face-to-face. Progressively the strips are joined by welding between high-frequency electrodes or steam-heated dies in a press. As convenient, welds D and E



No. 769449

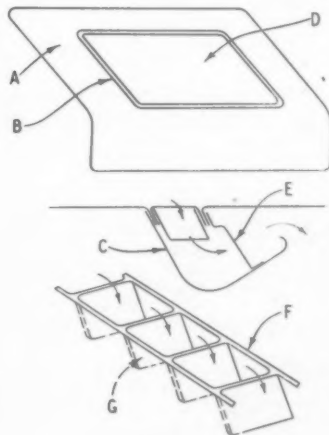
may be produced individually or simultaneously. In some instances it may be necessary to weld only half the length of the marginal portions at a time.

If the lining is held in position along its side edges by means of a piping enclosing a securing cord, the piping may be of similar material and also welded in position. Patent No. 769449. Fisher and Ludlow Ltd.

Cooling air inlet

Particularly in the case of rear-engined vehicles, difficulties are likely to be encountered in providing a cooling air inlet that is aesthetically pleasing yet not uneconomical in weight or cost. In the proposed construction the inlet offers the minimum interference with body line or air flow and the water trap serves as a structural reinforcement. The example shows the inlet incorporated in a sheet-metal panel which may serve as an engine inspection cover.

Panel A is formed with an aperture B of any suitable shape, the margin being turned inwardly to present a flange to which a water trap section C is attached. That part of the panel stamped out to form the aperture is flanged inwardly to form a complementary panel D and secured by a number of stays E to the water trap C. The air inlet passage between panels A and D may be masked by a grating F having a plurality of cross stays or baffles G

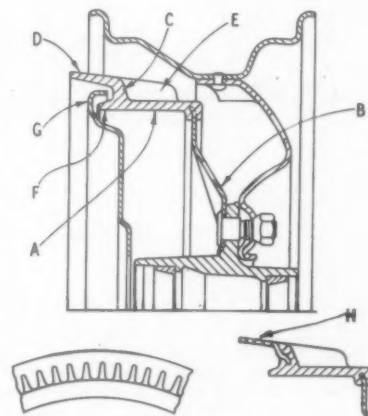


No. 770509

adapted to facilitate the entry of air and to influence the direction of flow. Patent No. 770509. Volkswagenwerk G.m.b.H. (Germany).

Brake drum

Improved heat dissipating characteristics and minimum distortion are claimed for this finned drum. The cast iron drum A is cast on the notched periphery of a pressed-steel head flange B and has near its open end a substantial radial flange C which is extended to form a flared annular circumferential rib D. On the exterior of the cylindrical portion of the drum are cast axially directed radial cooling fins E.



No. 771174

These fins terminate short of the head end of the drum to leave a clear cylindrical surface for chucking.

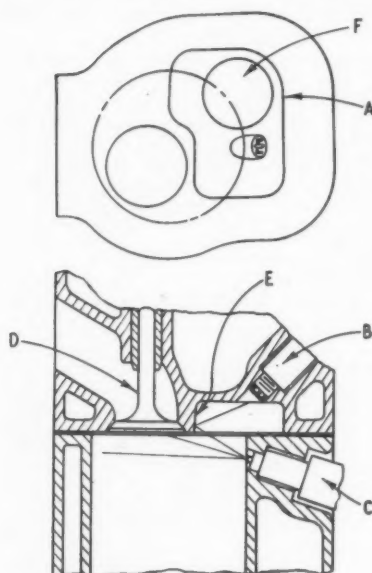
Beyond the radial flange C the drum is extended at F to form, with rib D, a sealing groove to receive the lip of the brake back plate G. Rib D projects into the air stream beyond the wheel rim and its coned surface assists the removal of any water collected in the groove. This feature, and also the protection afforded by rib D, permits the groove clearance to be more generous than is usual, thus simplifying manufacture and allowing more cooling air to flow through the drum.

Tests are stated to have shown that this drum is capable of making two to three times as many repetitive stops as does a conventional non-finned drum before reaching a non-safe operating temperature. In continuous operation or under steady state temperature conditions the drum absorbs about 67 per cent more power than a conventional drum, but with only 45 per cent increase in weight.

In a modified construction the circumferential rib H is pressed in steel, brass or copper and cast in the drum. It may be roughened or struck out to form tabs or otherwise worked to aid heat dissipation. The wheel disc and the drum head flange may be apertured to allow air to circulate over and through the drum. Patent No. 771174. The Budd Company (U.S.A.).

Fuel-injection, mixture-compressing engine

This arrangement of a petrol-injection engine has a relatively shallow combustion space A formed in the cylinder head and extending laterally beyond the circumference of the cylinder bore. The spark plug B is located at an angle in the roof of the combustion space and the injector C



No. 768520

at an angle in the cylinder wall; both lie in a plane containing the cylinder axis. Of the type delivering a conical fuel spray, the injector is directed towards the inlet valve D seated vertically in the face of the cylinder head. The uppermost portion of the fuel spray, however, enters the combustion space and is reflected from the surface of the wall E, which is at an angle to the vertical, towards the spark plug electrodes. Exhaust valve F is mounted vertically in the combustion space.

Advantages claimed for the arrangement are that the main portion of the fuel is directed towards the air entering past the inlet valve; a portion of the spray is reflected towards the spark plug zone and ensures ignition under all conditions of

operation; and the hot exhaust valve is adjacent the spark plug and minimizes any tendency to pinking. Patent No. 768520. Daimler-Benz A.G. (Germany).

Power-assisted steering gear

On this rack and pinion steering gear the hydraulic servo-motor intervenes only at moderate and low speeds when manual operation of the steering wheel becomes difficult. The gear comprises a casing A in one end of which is a cylinder B in which slides a piston mounted on a rod connected to the rack C. Engaging the rack is a pinion D secured on a sleeve E coupled by a rubber bushing F to the tubular steering shaft. Both sleeve E and the steering shaft are formed with diametrically opposite slots, the one longitudinally and the other at an angle of, say, 45 deg. These slots are engaged by four rollers on the head of a T-shaped member G carrying the slide of the hydraulic control valve H.

On one side of this valve is a branched return line to reservoir J and a centrally disposed pressure line from the pump K and the accumulator L. From the other side, two lines are connected respectively with opposite ends of the power cylinder B. These lines are cut by a two-position slide valve M which either places the lines in communication with the cylinder ends or shuts off the lines and places the two ends of the cylinder in communication with each other. Operation of this valve may be manual or automatic to bring in the hydraulic system at vehicle speeds less than 25 km/hr or when first or reverse gears are engaged.

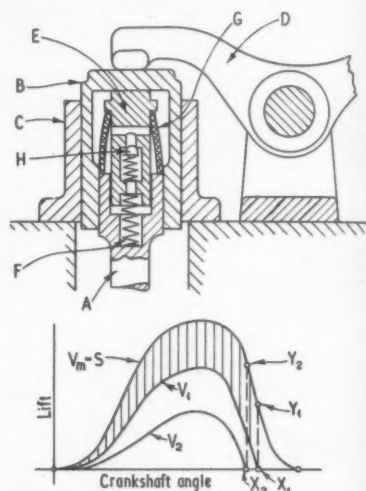
The rubber coupling F is so rigid that under normal running conditions the relationship between sleeve E and the steering shaft is unaffected. When, however, the rack is opposed to a resistance greater than the predetermined value, the coupling flexes angularly and the juxtaposed slots move the member G and the control valve slide to connect the pressure line to the appropriate end of the actuating cylinder. The piston then operates the steering gear through the rack. Patent No. 768264. S. A. Andre Citroën (France).

Automatic regulation of valve lift

The lift of an engine valve is automatically regulated in dependence on engine speed by means of a hydraulic device incorporated in the valve operating mechanism. Decreasing engine speed

gives a smaller, and increasing engine speed a larger, valve lift. The velocity of the stream of air or mixture entering the cylinder at low engine speeds is substantially increased as a result of the throttling action, while full charging is ensured at high engine speeds. On engines arranged with overlapped timing the system shows to advantage as the smaller valve lift at low engine speeds reduces the overlap and consequently the loss of unburnt mixture. Starting and tick-over are also improved, it is claimed.

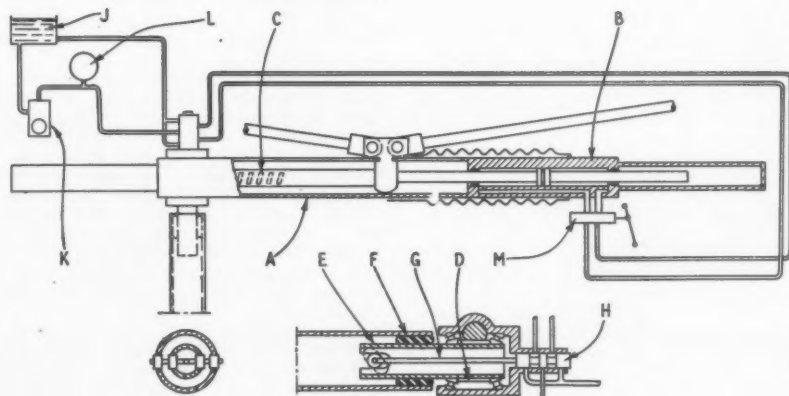
In the example, a pushrod A actuates,



No. 768336

through a plunger B guided in a bushing C, a conventional overhead rocker lever D. A piston-type regulating member E is guided in the end of the pushrod and, under the constraint of spring F, holds plunger B up to the rocker end. The head of member E is sealed to the top of the pushrod by means of a resilient bellows G to form a reservoir for hydraulic fluid. A spring-loaded, non-return valve H is arranged in the interior of member E to control the passage connecting the pressure space, below member E, and the reservoir. When the device is subjected to axial pressure, either by the pushrod when the engine valve is being opened or by the rocker when the valve is being returned to its seat, the non-return valve closes and fluid can be transferred from pressure space to reservoir only by way of the clearance between member E and the pushrod guide at a predetermined leak rate. Between strokes the clearance between plunger B and rocker lever D is taken up by spring F; valve H opening and fluid being returned from the reservoir to the pressure space.

The diagram shows pushrod stroke and valve lifts plotted against crankshaft angularity. At high speed the device is substantially rigid and the valve lift V_m is equal to the pushrod stroke S. However, as speed is decreased the valve lift is reduced as shown by curves V_1 and V_2 , and the closure of the valve occurs earlier, as at X_1 and X_2 . In these circumstances clearance arises in the operating mechanism from points Y_1 and Y_2 on the pushrod curve S. Also described is an application of the device to the pivot bearing of a tappet finger operating in conjunction with an overhead camshaft. In that instance the device does not add to the reciprocating weight of the mechanism. Patent No. 768336. Daimler-Benz A.G. (Germany).



No. 768264

AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

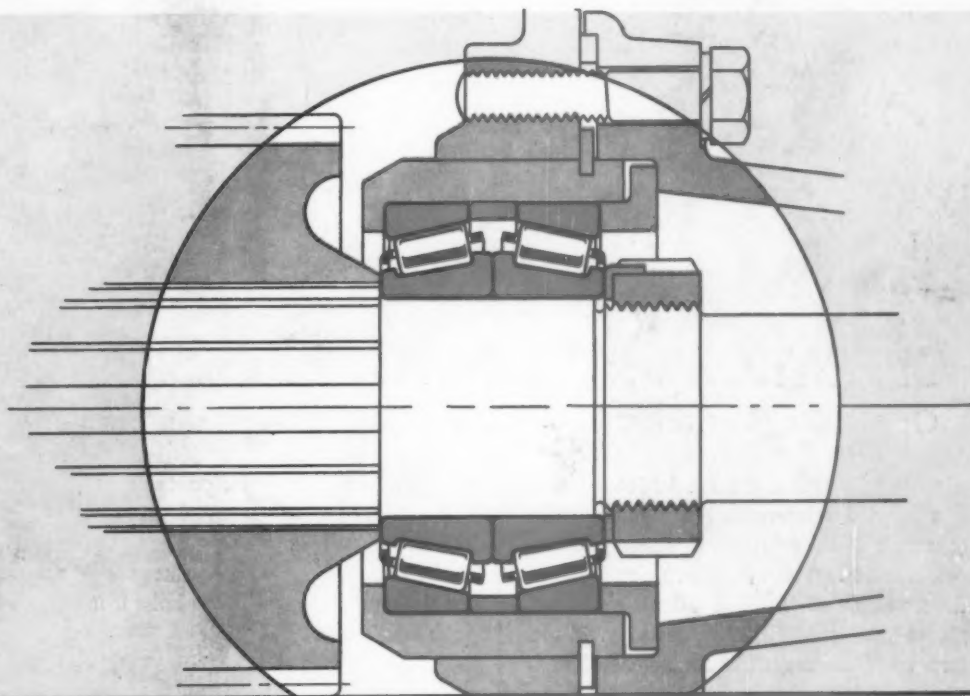
ENGINEERING
LIBRARY

Vol. 48 No. 2

FEBRUARY 1958

PRICE: 3s. 6d.

MAR 10 1958



Rear bearing for a gearbox

The heavy thrust loads imposed in certain circumstances, via the propeller shaft, can best be resisted by Timken tapered-roller bearings, which also provide ample radial load capacity.

The drawing shows a pair of Timken bearings in this situation, with their pre-load controlled by a spacer supplied with the bearings, giving an arrangement which is proof against mal-adjustment.

TIMKEN

Regd.
Trade Mark:
TIMKEN

tapered-roller bearings

MADE IN ENGLAND BY BRITISH TIMKEN LTD.
DUSTON NORTHAMPTON (HEAD OFFICE); DAVENTRY AND BIRMINGHAM

In this latest VDI monograph, the high standards of the earlier issues are maintained. The work should be of particular interest and value to vehicle and brake designers, as well as to supervising authorities responsible for brake testing. It is well produced, and the numerous diagrams should be intelligible to engineers, even if they are not familiar with technical German. However, the actual subject matter covers only 15 pages, so the price works out at about 1s 3d per page, which is rather high.

Teoria, Konstrukcia, Raschet i Ispitanie Dvigateli Vnutrenego Sgorania (Theory, Design, Calculation and Testing of Internal Combustion Engines).

In Russian

Moscow: PUBLICATIONS OF THE ACADEMY OF SCIENCE. 1957. 10 x 6½. 201 pp. Price 11 roub 90 kop (10s).

The work under review is the third volume of research reports published by the Internal Combustion Engine Laboratory of the Russian Academy of Science. It opens with an eight page article, by Stechkin, Mihailov and Sviridov, commemorating the eightieth anniversary of Prof. Nicolai Romanovich Briling, head of the reciprocating engine division of the laboratory. Briling, whose teaching and design work dates back to 1907, and who, in conjunction with V. I. Grinevetski is regarded as the originator of Russian compression ignition engine design and research, was responsible for the design and development of numerous engines mainly for transport applications and with outputs of up to 3,800 b.h.p. He has published numerous papers and several good text books, and his standing in Russia is equivalent to that of Sir Harry Ricardo in this country.

The first paper, by N. R. Briling, which occupies 30 pages, deals with the theory of the short-stroke diesel engine. In it, the author considers engines with stroke : bore ratios from 1.2 : 1, which is regarded as normal, to 0.8 : 1. First, he discusses the heat transfer problems to the coolant, then the starting characteristics, the peculiarities of the combustion process of the short-stroke engine, the effect of speed on cylinder charge, the effect of speed on inertia forces and dynamic loads, and the effect of stroke : bore ratio on thermal stresses and the specific output. This work is, perhaps, the most thorough and rigorous investigation so far published on this topical subject, and it is backed by some experimental results. From it, the author draws the following conclusions:

1. Reduction of the stroke : bore ratio increases the specific output and reduces specific weight. Thus, if for a conventional engine the specific weight amounts of 5.7 kg/b.h.p., then, for a short-stroke engine, it can be reduced to about 4.5 kg/b.h.p.
2. Similarly, a reduction of the stroke : bore ratio is of advantage

for automobile engines, since it reduces the overall height.

3. The reduction of stroke : bore ratios is of particular benefit so far as the crankshaft rigidity and bearing reliability are concerned: increased crankshaft rigidity, and the resultant reduction in deflection, leads to improved lubrication. Thus, it is concluded that reduction of the stroke : bore ratio substantially improves engine design parameters.

Investigations of the flow conditions in gas turbine combustion chambers are dealt with in 20 pages by Prof. A. I. Mihailov. The theoretical aspects of the flow distribution are considered, together with an appreciable amount of experimental evidence. A method based on these considerations, is suggested for the calculation of the flow velocity distribution at various points of the chamber. This method is also suitable for the calculation of temperature and fuel density distribution.

The theoretical considerations and experimental data relating to the determination of the specific heat of technical gases are dealt with in 18 pages by M. D. Apashev, with particular reference to the equations published in 1939 and 1948 by Vukalovich and Novikov. Next, the effects of combustion process parameters on the indicator diagram are considered by Y. B. Sviridov. This paper, which occupies 22 pages, discusses the subject with particular reference to the propagation velocity, its effect on pressure rise and the effect of that rise on the indicator diagram and the cycle efficiency. In conclusion, a practical example is fully worked out.

An eight page paper, by A. V. Rachinsky, discusses the effect of fuel in the charge of carburettor engines on both the flow into the cylinders and volumetric efficiency. Then, in a paper that covers 38 pages, K. A. Sharpo considers, mainly against the background of American engine data, the possibilities of standardizing transport engines. A short paper, nine pages, by B. S. Stechin and M. D. Apashev, deals with tests carried out to ascertain simultaneously the flame propagation and pressure changes in a spark ignition engine. The thermodynamic analysis of the engine combustion process is dealt with in some detail, in 30 pages, by Y. B. Sviridov. He limits his investigations to the determination of the relationships between burnt mass and volume, and the rise of pressure and the propagation of burnt charge, as well as the plot of temperature distribution in the charge at any given moment during combustion. This paper concludes with a worked out example illustrating the proposed method. Finally, a 12 page paper by A. P. Lebedinski deals with road tests of vehicles, with particular reference to towed-load trials, the load being provided by a second car of a type similar to that on test.

This most interesting collection of papers is of value to engine research workers. Prof. Briling's paper is particularly welcome, because of its clarification of the main aspects of the stroke : bore ratio problem and its influence on internal combustion engine design.

BOOKS of interest to AUTOMOBILE ENGINEERS

AUTOMOBILE CHASSIS DESIGN

By R. Dean-Averns. 2nd Ed. 30s. net. By post 31s. 4d.

AUTOMOBILE EFFICIENCY

Maintaining Performance with Electrical Test Equipment. By E. T. Lawson Helme, A.M.A.E.T. A.M.I.M.I. 10s. 6d. net. By post 11s. 3d.

AUTOMOBILE ELECTRICAL EQUIPMENT

By A. P. Young O.B.E., M.I.E.E., M.I.Mech.E. and L. Griffiths, M.I.Mech.E., A.M.I.E.E. 5th Ed. 25s. net. By post 26s. 5d.

DIESEL MAINTENANCE

A Practical Guide to the Servicing of the Modern Automotive Diesel Engine. By T. H. Parkinson, M.I.Mech.E. Edited by Donald H. Smith, M.I.Mech.E. 4th Ed. 12s. 6d. net. By post 13s. 6d.

ELECTRICAL SERVICING OF THE MOTOR VEHICLE

Principles, Design and Choice of Test Apparatus. By E. T. Lawson Helme, A.M.A.E.T., A.M.I.M.I. 8s. 6d. net. By post 9s. 4d.

GAS TURBINES AND JET PROPULSION

By G. Geoffrey Smith, M.B.E., Revised by F. C. Sheffield. 6th Ed. 35s. net. By post 36s. 9d.

THE MODERN DIESEL

Automotive Oil Engines for Transport, Marine and Industrial Use. By Donald H. Smith, M.I.Mech.E. 12th Ed. 12s. 6d. net. By post 13s. 7d.

THE MOTOR TRADE

A Guide to Selling, Servicing and Management. By H. E. Milburn, M.I.Mech.E. 21s. net. By post 22s. 1d.

SERVICING GUIDE TO BRITISH MOTOR VEHICLES, CARS, COMMERCIAL VEHICLES AND TRACTORS. Vol. 1.

63s. net. By post 66s.

SERVICING GUIDE TO BRITISH MOTOR VEHICLES, CARS, COMMERCIAL VEHICLES AND TRACTORS. Vol. 2.

42s. net. By post 44s. 6d.

SERVICING GUIDE TO BRITISH MOTOR VEHICLES, CARS, COMMERCIAL VEHICLES AND TRACTORS. Vol. 3.

50s. net. By post 52s. 6d.

SERVICING GUIDE TO BRITISH MOTOR VEHICLES, CARS, COMMERCIAL VEHICLES AND TRACTORS. Vol. 4.

57s. 6d. net. By post 60s.

Obtainable at all booksellers or from : **ILIFFE & SONS LTD., Dorset House, Stamford St., London, S.E.1.**

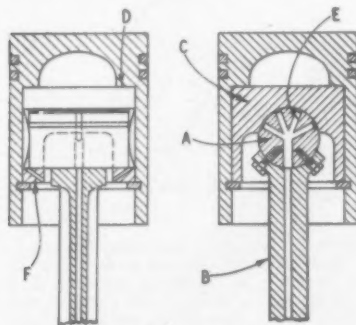
CURRENT PATENTS

A REVIEW OF RECENT AUTOMOBILE SPECIFICATIONS

Piston and connecting rod assembly

Gudgeon pin bearings in high performance engines are highly stressed mechanically and thermally and are of relatively restricted area. The attendant problems are largely met by the use of high-quality bearing materials and meticulous accuracy in machining and assembly. This design, intended particularly for two-stroke engines of the fuel-injection type, aims to provide a long-life, plain bearing using only a cheap bearing material.

The pin A is seated directly in the radiused end of the connecting rod B and secured by radially positioned set screws. An uninterrupted plain bearing for the pin is provided in a seating C of a suitable aluminium alloy. The seating, recessed on the underside to clear the connecting rod,



No. 769352

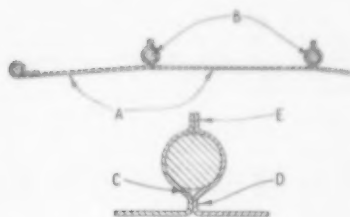
is cylindrical in shape and is fitted into the piston to abut a shoulder D. A spring ring retains it in its assembled position.

Lubricating oil is fed to the bearing by way of the drilled connecting rod and radial ducts E in the pin. Grooves for the distribution of the oil are machined longitudinally in the surface of the pin. On each side of the seating drillings F are provided for the return of oil to the sump. Patent No. 769352. Klöckner-Humboldt-Deutz A.G. (Germany).

Head lining

It is known to produce a head lining for a vehicle by sewing together strips of lining material with at least two rows of stitching suitably spaced apart to define a transverse pocket through which a listing rod can be passed. The invention provides an improved method of construction on those lines.

The lining is built up from a number of shaped strips A of a material comprising a textile base coated with polyvinyl chloride. It is secured in position in the vehicle by means of listing rods B passing through pockets C. To form these pockets, marginal portions of adjacent strips are folded upwardly so that the coated surfaces are face-to-face. Progressively the strips are joined by welding between high-frequency electrodes or steam-heated dies in a press. As convenient, welds D and E



No. 769449

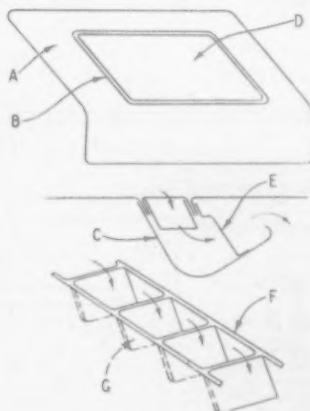
may be produced individually or simultaneously. In some instances it may be necessary to weld only half the length of the marginal portions at a time.

If the lining is held in position along its side edges by means of a piping enclosing a securing cord, the piping may be of similar material and also welded in position. Patent No. 769449. Fisher and Ludlow Ltd.

Cooling air inlet

Particularly in the case of rear-engined vehicles, difficulties are likely to be encountered in providing a cooling air inlet that is aesthetically pleasing yet not uneconomical in weight or cost. In the proposed construction the inlet offers the minimum interference with body line or air flow and the water trap serves as a structural reinforcement. The example shows the inlet incorporated in a sheet-metal panel which may serve as an engine inspection cover.

Panel A is formed with an aperture B of any suitable shape, the margin being turned inwardly to present a flange to which a water trap section C is attached. That part of the panel stamped out to form the aperture is flanged inwardly to form a complementary panel D and secured by a number of stays E to the water trap C. The air inlet passage between panels A and D may be masked by a grating F having a plurality of cross stays or baffles G

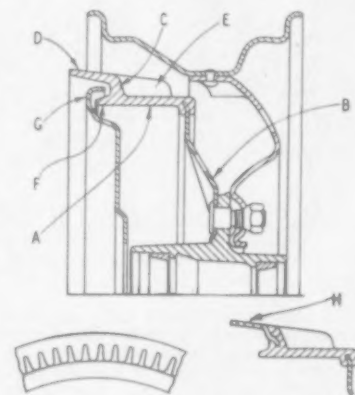


No. 770509

adapted to facilitate the entry of air and to influence the direction of flow. Patent No. 770509. Volkswagenwerk G.m.b.H. (Germany).

Brake drum

Improved heat dissipating characteristics and minimum distortion are claimed for this finned drum. The cast iron drum A is cast on the notched periphery of a pressed-steel head flange B and has near its open end a substantial radial flange C which is extended to form a flared annular circumferential rib D. On the exterior of the cylindrical portion of the drum are cast axially directed radial cooling fins E.



No. 771174

These fins terminate short of the head end of the drum to leave a clear cylindrical surface for chucking.

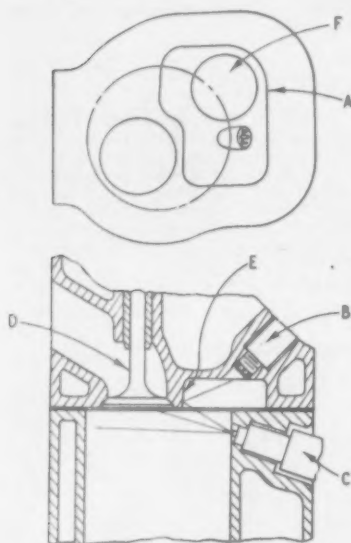
Beyond the radial flange C the drum is extended at F to form, with rib D, a sealing groove to receive the lip of the brake back plate G. Rib D projects into the air stream beyond the wheel rim and its coned surface assists the removal of any water collected in the groove. This feature, and also the protection afforded by rib D, permits the groove clearance to be more generous than is usual, thus simplifying manufacture and allowing more cooling air to flow through the drum.

Tests are stated to have shown that this drum is capable of making two to three times as many repetitive stops as does a conventional non-finned drum before reaching a non-safe operating temperature. In continuous operation or under steady state temperature conditions the drum absorbs about 67 per cent more power than a conventional drum, but with only 45 per cent increase in weight.

In a modified construction the circumferential rib H is pressed in steel, brass or copper and cast in the drum. It may be roughened or struck out to form tabs or otherwise worked to aid heat dissipation. The wheel disc and the drum head flange may be apertured to allow air to circulate over and through the drum. Patent No. 771174. The Budd Company (U.S.A.).

Fuel-injection, mixture-compressing engine

This arrangement of a petrol-injection engine has a relatively shallow combustion space A formed in the cylinder head and extending laterally beyond the circumference of the cylinder bore. The spark plug B is located at an angle in the roof of the combustion space and the injector C



No. 768520

at an angle in the cylinder wall; both lie in a plane containing the cylinder axis. Of the type delivering a conical fuel spray, the injector is directed towards the inlet valve D seated vertically in the face of the cylinder head. The uppermost portion of the fuel spray, however, enters the combustion space and is reflected from the surface of the wall E, which is at an angle to the vertical, towards the spark plug electrodes. Exhaust valve F is mounted vertically in the combustion space.

Advantages claimed for the arrangement are that the main portion of the fuel is directed towards the air entering past the inlet valve; a portion of the spray is reflected towards the spark plug zone and ensures ignition under all conditions of

operation; and the hot exhaust valve is adjacent the spark plug and minimizes any tendency to pinking. *Patent No. 768520. Daimler-Benz A.G. (Germany).*

Power-assisted steering gear

On this rack and pinion steering gear the hydraulic servo-motor intervenes only at moderate and low speeds when manual operation of the steering wheel becomes difficult. The gear comprises a casing A in one end of which is a cylinder B in which slides a piston mounted on a rod connected to the rack C. Engaging the rack is a pinion D secured on a sleeve E coupled by a rubber bushing F to the tubular steering shaft. Both sleeve E and the steering shaft are formed with diametrically opposite slots, the one longitudinally and the other at an angle of, say, 45 deg. These slots are engaged by four rollers on the head of a T-shaped member G carrying the slide of the hydraulic control valve H.

On one side of this valve is a branched return line to reservoir J and a centrally disposed pressure line from the pump K and the accumulator L. From the other side, two lines are connected respectively with opposite ends of the power cylinder B. These lines are cut by a two-position slide valve M which either places the lines in communication with the cylinder ends or shuts off the lines and places the two ends of the cylinder in communication with each other. Operation of this valve may be manual or automatic to bring in the hydraulic system at vehicle speeds less than 25 km/hr or when first or reverse gears are engaged.

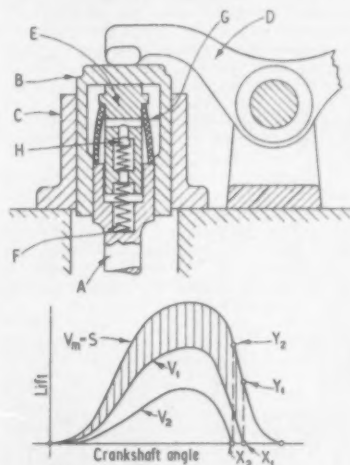
The rubber coupling F is so rigid that under normal running conditions the relationship between sleeve E and the steering shaft is unaffected. When, however, the rack is opposed to a resistance greater than the predetermined value, the coupling flexes angularly and the juxtaposed slots move the member G and the control valve slide to connect the pressure line to the appropriate end of the actuating cylinder. The piston then operates the steering gear through the rack. *Patent No. 768264. S. A. Andre Citroën (France).*

Automatic regulation of valve lift

The lift of an engine valve is automatically regulated in dependence on engine speed by means of a hydraulic device incorporated in the valve operating mechanism. Decreasing engine speed

gives a smaller, and increasing engine speed a larger, valve lift. The velocity of the stream of air or mixture entering the cylinder at low engine speeds is substantially increased as a result of the throttling action, while full charging is ensured at high engine speeds. On engines arranged with overlapped timing the system shows to advantage as the smaller valve lift at low engine speeds reduces the overlap and consequently the loss of unburnt mixture. Starting and tick-over are also improved, it is claimed.

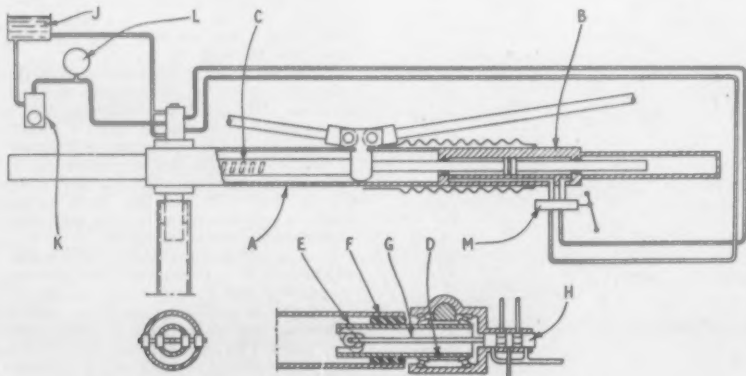
In the example, a pushrod A actuates,



No. 768336

through a plunger B guided in a bushing C, a conventional overhead rocker lever D. A piston-type regulating member E is guided in the end of the pushrod and, under the constraint of spring F, holds plunger B up to the rocker end. The head of member E is sealed to the top of the pushrod by means of a resilient bellows G to form a reservoir for hydraulic fluid. A spring-loaded, non-return valve H is arranged in the interior of member E to control the passage connecting the pressure space, below member E, and the reservoir. When the device is subjected to axial pressure, either by the pushrod when the engine valve is being opened or by the rocker when the valve is being returned to its seat, the non-return valve closes and fluid can be transferred from pressure space to reservoir only by way of the clearance between member E and the pushrod guide at a predetermined leak rate. Between strokes the clearance between plunger B and rocker lever D is taken up by spring F; valve H opening and fluid being returned from the reservoir to the pressure space.

The diagram shows pushrod stroke and valve lifts plotted against crankshaft angularity. At high speed the device is substantially rigid and the valve lift V_m is equal to the pushrod stroke S. However, as speed is decreased the valve lift is reduced as shown by curves V_1 and V_2 and the closure of the valve occurs earlier, as at X_1 and X_2 . In these circumstances clearance arises in the operating mechanism from points Y_1 and Y_2 on the pushrod curve S. Also described is an application of the device to the pivot bearing of a tappet finger operating in conjunction with an overhead camshaft. In that instance the device does not add to the reciprocating weight of the mechanism. *Patent No. 768336. Daimler-Benz A.G. (Germany).*



No. 768264

INHERENT DEPENDABILITY




under arduous conditions

Operating anywhere, from monsoon country to under midnight suns, Hardy Spicer transmissions have earned a reputation for ruggedness that takes a deal of living up to. The inherent dependability of Hardy Spicer transmission equipment is the product of long experience, constant development and the highest standards of engineering skill. That is why precision-built Hardy Spicer equipment is standard on most British and many foreign vehicles designed for really hard work.

HARDY SPICER TRANSMISSION EQUIPMENT

Inherent Dependability for **PASSENGER VEHICLES**

A Member of the  **Birchfield Group**

HARDY SPICER LIMITED, BIRCH ROAD
WITTON, BIRMINGHAM B17 4JH

Just call me 'Doc'

'Doc', here, to whom we introduce you now, is a personification of the many capable Smiths and Joneses who form the John Bull teams of scientists and technicians. 'Doc' has an infinitely elastic cranium, crammed with sound, practical knowledge of rubber in all its applications. He will always be happy to put his brain to work on *your* behalf.

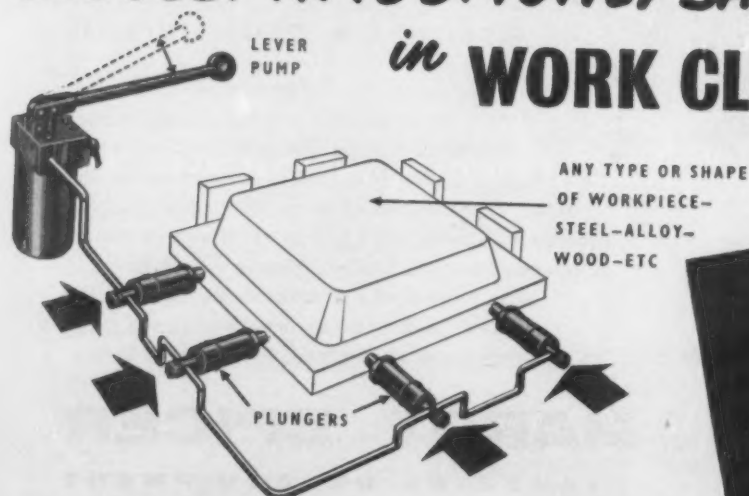


JOHN BULL *Rubber*



JOHN BULL RUBBER CO. LTD. (INDUSTRIAL SALES DIVISION) LEICESTER TELEPHONE 3651

BIGGEST TIME & MONEY SAVER *in* WORK CLAMPING



These plungers can exert a pressure of from 800lbs—4 tons.
Can be used in groups of any number.

**POWER JACKS
LIMITED**
MAYLANDS AVENUE HEMEL HEMPSTEAD
TEL: 0484 3000 - GRAM: NEWSPAPER, HEMEL HEMPSTEAD

Maximum pressure with
smallest plungers
Easily adaptable to any
fixture design

Simultaneous
plunger action
Minimum
floor to floor time.

Send today for illustrated brochure H/243



Metropolitan Plastics Limited



Very sharp shooting

forgive our enthusiasm, but working as we are to the highest standards of precision as a daily routine, we naturally have an interest in such things. If precision work (in thermo-setting plastics) is what you're looking for, plus the capacity to turn out a job bang on time, you'll be sure to find it with; Metropolitan Plastics Limited.

Glenville Grove Deptford London SE8 Telephone: rtdeway 1172 *Specialists in Thermo-setting Plastics*



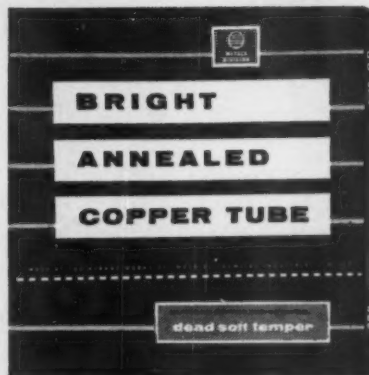
I.C.I. small diameter Tubes

*Quality •
Reliability •
Immediate
Delivery*

now in this
distinctive carton



Each handy carton contains a 25 ft. double pancake coil of easily manipulated tubing in one of seven outside diameter sizes between $\frac{1}{8}$ in. and $\frac{1}{2}$ in.

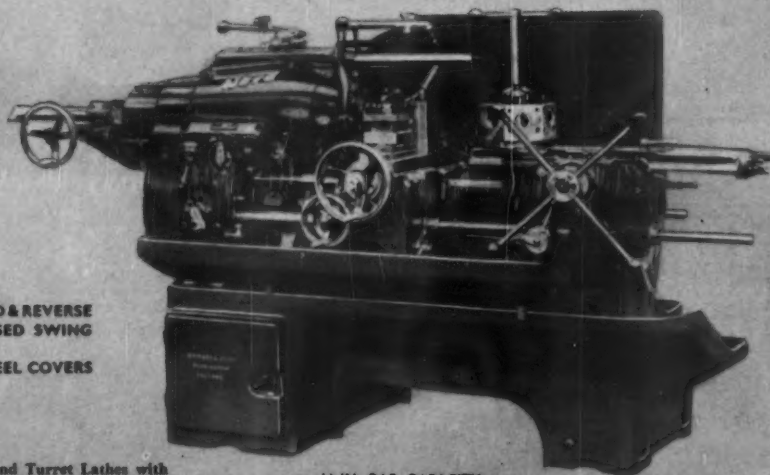


IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON, S.W.1

CT13a

THE NEW 3C *For Maximum Production*

Ward
CAPSTAN
LATHE



▶ INBUILT ELECTRICAL EQUIPMENT
▶ 12 SPINDLE SPEEDS—BOTH FORWARD & REVERSE
▶ RAISED CENTRES GIVING INCREASED SWING
▶ LARGE CAPACITY SWarf PAN
▶ BED PROTECTED BY STAINLESS STEEL COVERS

Our complete range includes Capstan and Turret Lathes with capacities up to 35 $\frac{1}{2}$ in. swing over bed and 8 $\frac{1}{2}$ in. dia. hole through spindle

Full details on request

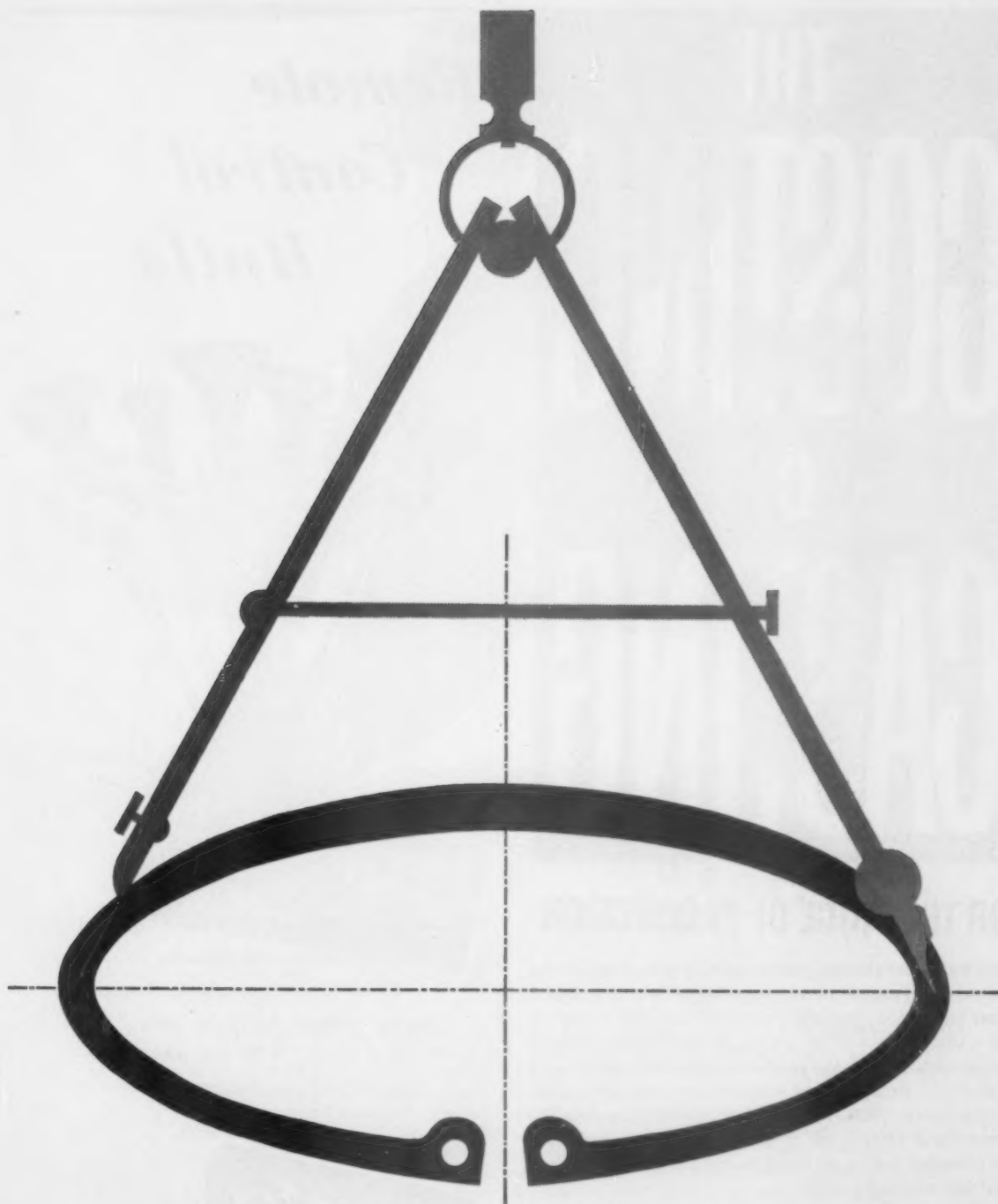
1 $\frac{1}{2}$ IN. BAR CAPACITY
14 $\frac{1}{2}$ IN. SWING OVER BED COVERS

H.W. WARD & CO
LTD

SELLY OAK
BIRMINGHAM 29

TELEPHONE SELLY OAK 1131





360° safe: SEEGER CIRCLIPS of all sizes are designed
and thrice tested for uniform pressure throughout their circumference

Automotive Engineering Limited



One of the Sheepbridge Engineering Group
The Green, Twickenham, Middlesex
Telephone: POPesgrove 2206/9 Telegrams: MOTIF, Twickenham

THE COSTING OF CASTING

OR THE PRICE OF PRODUCTION

From blue-print through pattern-making and casting to the finished part, Franber offers a comprehensive service designed to cut production costs and time. And very many firms *do* find it cheaper, as well as quicker, to buy Franber finished parts to specifications, and pass them straight to sub-assembly or assembly. Franber offers complete, precision production for component parts, in aluminium, gun-metal, phosphor bronze—lead bronze, etc. (one speciality being gun-metal and phosphor bronze bushes in all sizes, including Graphite filled self-lubricating types).

This comprehensive service costs less than you expect—and the stickier production problems are welcomed!

Have a word with our Technical Director at Cleckheaton 961.

FRANCIS W. BIRKETT & SONS LTD., CLECKEATON, YORKS., ENGLAND.

Non Ferrous Founders and Engineers

Telephone: Cleckheaton 961/2/3.



Remote Control Units



All types of Remote Control Units are produced by Gills including

Units made to manufacturers specific designs. Famous for twenty years

for one reason only—they are probably the best.

GILL'S Cables Ltd

PACKINGTON HALL WORKS · LICHFIELD · STAFFS

Telephone: WHITTINGTON 284 & 285

Telegrams: "REMOTE", LICHFIELD



Putting two and two together and making five ! At least, that's how it appears when you consider the saving in time and cost by changing over to tapping screws. Without doubt, the tapping screw does display a number of very definite advantages over the conventional machine screw. It obviates the use of nuts. With its self-locating point, it forms its own thread and eliminates a separate and expensive tapping operation. It makes for easier assembly, is stronger, cheaper and faster. And when used in conjunction with the Phillips recessed head, designed for power driving without damage to either work or worker, it is obviously safer. Putting two and two together, the tapping screw simply ensures a better job. Why not change over to tapping screws and prove it for yourself?

Linread

tapping screws for economy and safety

LINREAD LTD. COX ST. BIRMINGHAM 3

SLOTTED AND PHILLIPS RECESSED HEAD MACHINE SCREWS AND TAPPING SCREWS • HIGH TENSILE HEXAGON HEAD BOLTS AND SETSCREWS
AIRCRAFT BOLTS, SCREWS AND RIVETS • SEMS • RIVNUTS • CUSTOM DESIGNED COLD FORGED FASTENERS • ALEX SCREWPLUGS.

You cannot be too careful about Cutting Fluids

The present necessity to reduce the costs of production makes it essential that all cutting fluid users exercise care in the selection and use of these production lubricants.

Much can be done by (1) careful selection, (2) increased efficiency of application, (3) correct handling and storage. Fletcher Miller Representatives will be pleased to assist users to this end—just write or telephone for this service.

The latest edition of the Fletcher Miller booklet "Cutting Fluids" also contains much useful information to assist engineers. Have you had your free copy yet? Ask for Publication No. SP.173 on your business card or heading.



FLETCHER MILLER

cutting fluids

YOUR PARTNERS IN PRODUCTION

FLETCHER MILLER LTD · ALMA MILLS · HYDE CHESHIRE

Telephone: HYDE 3471 (5 lines)

Telegrams: EMULSION, HYDE

CF106

Don't SPECULATE on springs

You WILL get the best from
LITCHFIELD BROTHERS

LITCHFIELD BROTHERS LTD.
BROADHOLME · BELPER · DERBYSHIRE

PHONE
BELPER
234

DAVID BROWN

new 552

5 SPEED GEARBOX

A recent addition to the range of well-proved David Brown gearboxes, the Model 552 is a really sturdy unit with a wide range of application, as a choice of three control positions coupled with a selection of four alternative ratios make it readily adaptable for coach, long distance or local haulage.

Outstanding features include constant mesh gears for the top four ratios, simplicity of design and ease of operation, a combination which ensures trouble-free service under all conditions.

MAXIMUM ENGINE TORQUE 250 lb. ft.

Gear	Under drive	Under drive (alternative)	Under drive (alternative)	Overdrive
5th	1/1	1/1	1/1	0.76/1
4th	1.60/1	1.56/1	1.58/1	1/1
3rd	2.80/1	2.39/1	2.57/1	1.84/1
2nd	4.53/1	3.63/1	3.90/1	3.63/1
1st	8.14/1	6.51/1	7.00/1	6.52/1
Reverse	8.40/1	6.74/1	7.23/1	6.71/1



Standard Controls

CENTRE

FORWARD

SEMI-FORWARD

THE
DAVID BROWN
CORPORATION (SALES) LIMITED
AUTOMOBILE GEARBOX DIVISION
PARK WORKS HUDDERSFIELD

G.E.C.

fractionals

put power where you want it



The Busy Bee from G.E.C.

Power for many purposes. Power to drive your own plant efficiently, or to add further distinction to the equipment you make and sell. Power. As much (up to 1 h.p.) or as little as you need, in a wide range of mountings, but always with the reliability for which all G.E.C. engineering is famous. Power, from sturdy, dependable G.E.C. Fractionals. Most sizes and mountings are held in stock—that's another advantage of dealing with the G.E.C.

G.E.C. manufacture many types and sizes of fractional motors for light industrial and domestic drives—whether for your plant or products our engineers will always be pleased to help you choose the right motor for the job.

Fully detailed illustrated publication on application.


THE GENERAL ELECTRIC CO. LTD.,
MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

MORRIS

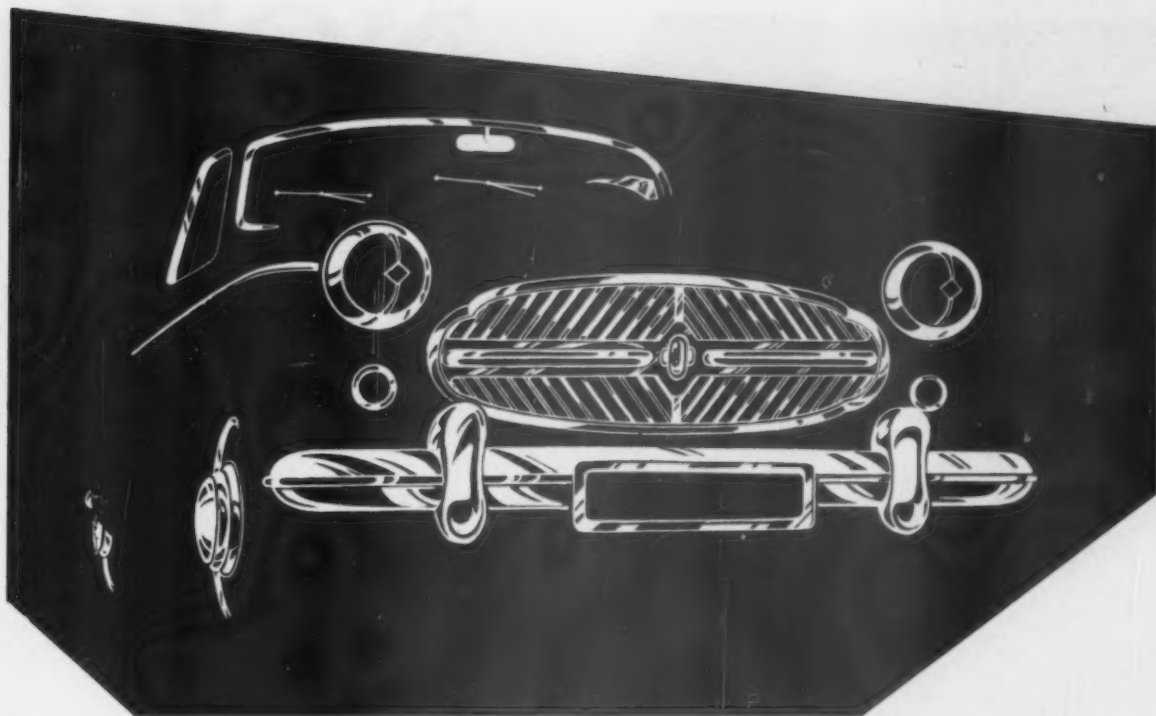
USE

CLANCEY

CAST-IRON VALVE GUIDES
AND
CHILLED-FACED TAPPETS



G·CLANCEY LTD · BELLE VALE · HALESOWEN
TELEPHONE: CRADLEY HEATH · 69411-2-3



**THE FITTINGS COUNT
SUCH A LOT....**

... ask any motorist, whether he drives a revered veteran, the best car in the world, a track-tuned roadster or a home-made special.

The most useful modern metal—**Stainless Steel**—is being used more and more for motor-car trim and fittings. Stainless Steel is ideal for the job, no peeling or chipping, no polishing, all it requires is a wash with warm soapy water and a rub up with a leather.

If you simply use your car to take you there and back to see how far it is, Stainless Steel trim will turn you into a car-proud discriminating enthusiast.



... why not Bumpers too?

FIRTH-VICKERS STAINLESS STEELS LTD. - SHEFFIELD

Telephone: Sheffield 42051



WHY THE TWISTED TEETH?

Because every tooth on a 'Shakeproof' washer acts as a strut, preventing the screw or nut backing off. Every tapered, twisted tooth creates powerful spring tension between work surfaces, tension that ensures the lock is secure, tight. The sharp edges of each tooth anchor firmly, without milling. The greater the vibration — the stronger the lock. You can't find a more powerful lock than 'Shakeproof' Lock Washers, available in a wide range of sizes and types.



'Shakeproof' lock washers are available in tempered & hardened high carbon spring steel, or phosphor bronze.

A.I.D. APPROVED

"SHAKEPROOF"

REG. TRADE MARK Nos. 841535

LOCK WASHERS AND LOCKING TERMINALS

British Patents Nos. 406556 — 518146

BARBER & COLMAN LTD
BROOKLANDS, SALE, CHESHIRE

TELEPHONE: SALE 2277 (4 LINES)
TELEGRAMS: "BARCOL" SALE



Dealers and Factors enquiries to the following appointed "SHAKEPROOF" stockists:

George Boyd & Co. Ltd. 229 Buchanan Street, Glasgow C.1.
Brown Bros. Ltd. (all Branches)
Wm. Galloway & Co. Ltd. Blaydon-on-Tyne.
F. Miller & Co. (London) Ltd. Rectory Road, Acton, London W.3.
Nettlefold & Moser Ltd. (all Branches)
Nobby Distributors Ltd. 438 Harrow Road, London W.9.
Wordrew Ltd. 173 Princess Street, Manchester, 1.

SB 4

NOW Tedddington

offer a complete range of
pneumatic gauging equipment

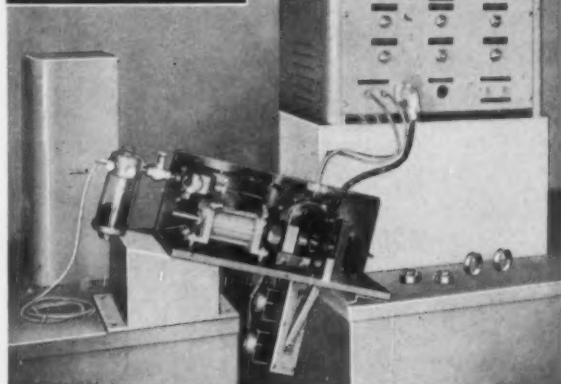
The importance of the announcement that Tedddington are manufacturing, in technical collaboration with Moore Products of Philadelphia, a range of pneumatic gauging equipment lies in the fact that for the first time British industry is offered a complete range covering manual and automatic gauging and complete automatic machine control. The major advantages of speed, accuracy and robustness are common to each application.

In brief . . .

- * magnifications up to 12,500
- * great accuracy — repeatability within 1% of scale range
- * positive operation — high pressure system unaffected by dirt or coolant on the work
- * high wear tolerance — up to 0.003" without affecting accuracy

MANUAL

Single and multiple gauging of diameters, taper, thickness, straightness and other dimensions.



AUTOMATIC High speed multi-dimensional gauging machines with automatic segregation of work and feed-back signals for machine control.

MACHINE CONTROL "In process" or "post process" gauging with 5 stage feed-back signalling.

Write for further details available in leaflet A & I/AE/101.

TEDDINGTON INDUSTRIAL EQUIPMENT LTD.
SUNBURY - ON - THAMES MIDDLESEX

Telephone: Sunbury-on-Thames 600 (9 lines)
Grams & Cables: Teddequip, Sunbury-on-Thames; Telex: 22742 Teddcontsbry



71859



**In any language
TORRINGTON NEEDLE BEARING
means high capacity!**

From Kalamazoo to Calcutta, the Torrington Needle Bearing is synonymous with *high capacity in minimum space at low cost.*

The unique capabilities of the Needle Bearing have won it world-wide acceptance, established it as "standard equipment" in products made all over the globe.

A full complement of free-running rollers retained by a thin hardened shell, which serves as the outer race, affords more lines of contact, and thus greater radial load capacity than other bearings of the same size.

As important as the Needle Bearing itself is the knowledge and experience our Bearings Division places at your disposal. With thousands of successful applications behind them, Torrington engineers are eminently qualified to show you the benefits of Needle Bearings in your products.

TORRINGTON BEARINGS

*The Torrington Company Ltd. Bearings Division: Torrington Avenue, Coventry.
London & Export Office: 7-10 Eldon Street, EC2. Glasgow Office: 14 Moir Street, CI*

**Torrington Needle
Bearings give
you these benefits**

- compactness and light weight
- unequalled radial load capacity
- low starting and running friction
- low unit cost
- run on hardened shafts
- allow larger and stiffer shafts



**MADE AND STOCKED AT OUR
ENGLISH FACTORY**

FOR SOUND CASTINGS

CONSULT

We are manufacturers of high duty iron castings for the motor car and allied trades.

As one example we show one of the biggest brake drums in use today

—Cast by Triplex.



TRIPLEX FOUNDRY LTD

UPPER CHURCH LANE, TIPTON, STAFFS. Telephone Tipton 1293 (4 lines)

HIGH DUTY IRONFOUNDERS

A Member of the Triplex Foundries Group



FOR

Diecastings as strong as steel



ALUMINIUM BRONZE CO. LTD.

Wallows Lane · Walsall · Staffs.

Telephone WALSALL 2108 (3 lines)
Telegrams "ABCO WALSALL"



**AUTOMATIC
DRILLING OF
CRANKSHAFTS**

AT FORD MOTOR CO. LTD.

ARCHDALE
**UNIMATIC TRANSFER
MACHINES**

CONSULT ARCHDALE ON ALL ASPECTS OF AUTOMATION

JAMES ARCHDALE & CO. LTD. LEDSAM ST. BIRMINGHAM

A member of the Staveley Coal & Iron Company Ltd.

TELEPHONE: EDGbaston 2276 (3 lines) TELEGRAMS: ARCHDALE BIRMINGHAM

SOLE SELLING AGENTS: ALFRED HERBERT LTD. COVENTRY

Famous Quotations



Joseph ADDISON (1672-1719)

"There is nothing more requisite in business than despatch."



Sir Arthur Conan DOYLE (1859-1890)

"It has long been an axiom of mine that the little things are infinitely the most important."



Thomas Alva EDISON (1847-1931)

"Genius is one per cent inspiration and ninety-nine per cent perspiration."



Samuel CLEMENS (Mark Twain) (1835-1910)

"The best thing in all this world that can befall a man is to be born lucky."



Thomas CARLYLE (1795-1881)

"The glory of a workman, still more of a master-workman, that he does his work well, ought to be his most precious possession; like the 'honour of a soldier', dearer to him than life."

BUT



**IF YOU
REQUIRE THE BEST
ALUMINIUM &
NON-FERROUS
CASTINGS
LET
SANDWELL
QUOTE**



Specialists in the production of the finest quality Sand Castings, Gravity Die Castings and Pressure Die Castings in all Light Alloys and Non-Ferrous Metals by the most modern methods.

Makers of the famous 'SOUNDWELL' Factory Fire Alarm Bell. Illustrated literature on request.

THE SANDWELL CASTING CO.

BANK STREET FOUNDRY, WEST BROMWICH

Tel: STOnecross 2231 (4 lines) Grams: "RECAST," WEST BROMWICH

One of the SANBRA Group of Companies

an egg or an omnibus!



**PARKER
PACKING**

will see it across the World!

Situated with direct access by water to all the Thameside docks... equipped for heavy handling—with acres of storage space... Parker Packing also offers the "know-how" and conscientious care which provide maximum protection for valuable exports.

Parker Packing is a highly specialised organisation, developed and trained for the specific purpose of packing for export with effective economy.

Get a fresh slant on your packing problems by calling in

The Parker Packing Co. Ltd.,

Victoria Wharf, Grove Street, Deptford, S.E.8.

Telephone TIDeway 6511



PARKER PACKING
—PROTECTS YOUR EXPORTS!



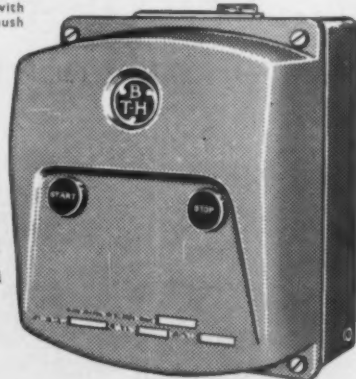
A.C. DIRECT-ON-LINE

CONTACTOR STARTER

Type DOC71 for three-phase or single-phase non-reversing squirrel-cage induction motors.

This starter is sturdy in construction, elegant in appearance and dependable in operation. It is available for motors up to 5 horsepower, and complies with BS. 587.1957 for "Frequent Duty", i.e. forty starts per hour.

The starter, comprising a triple-pole contactor with normally-open auxiliary switch and triple-pole hand-reset thermal overload relay, is enclosed in a distinctive die-cast aluminium case with integral START-STOP push buttons.



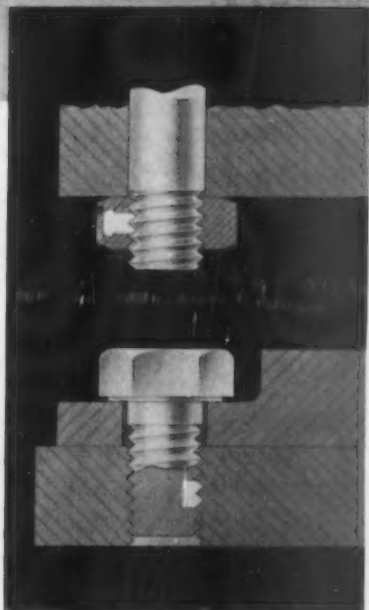
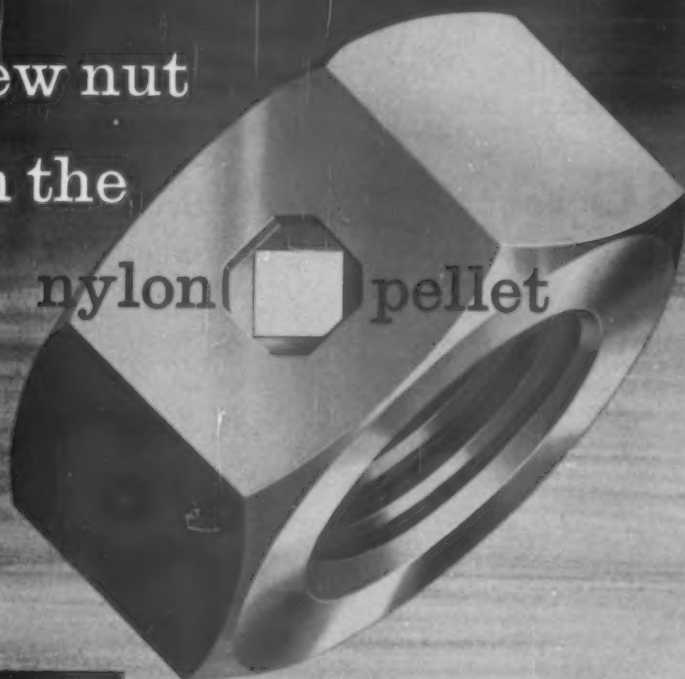
BRITISH THOMSON-HOUSTON

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED • BUGBY • ENGLAND

A333

WEDGLOK

the new nut
with the
nylon pellet



Wedglok nuts are completely self-locking. They will not work loose through vibration or reversal of stress. They need no locking devices—and the locking-action is unaffected by age or temperatures within the normal range.

How is it done?

In a Wedglok nut the locking element consists of a tough, resilient nylon pellet. This is inserted in the body of the nut and projects slightly above the crest of the thread. When the nut is turned the pellet sets up a wedging action, gripping the threads tightly. This counter-thrust creates metal to metal engagement of mating threads. The Wedglok principle can be applied to screws as well.

If it's a matter of how to fasten one thing
to another . . . get in touch with

GKN

Wedglok Self-Locking Products are manufactured under licence in the United Kingdom solely by
Guest Keen & Nettlefolds (Midlands) Ltd., Screw Division, Box 24, Heath St., Birmingham 18. Tel: Smethwick 1441

s/wk/3825

Overcome by 'transport troubles'? Here's the answer..!



THE **ABC** GOODS TRANSPORT GUIDE

will tell you **HOW** to send **ANYTHING** — **ANYWHERE** !

The ABC GOODS GUIDE is an essential reference source for consignors in all industries. This new issue provides page after page of found-in-a-flash information about the nearest and quickest means of despatching any kind of goods. ALL long distance road transport operators (independent and British Road Services) are listed in town alphabetical order in the Transport Services ABC Section, plus up-to-date details of warehousing, wharfingers, goods-by-air, ferry services, coastwise shipping and other specialized services.

★ **JANUARY — JUNE** issue ready **NOW**

Half-yearly issues Jan. — June 1958; and July — Dec. 1958 **5s. each** (POST FREE)

ORDER FORM

Iliffe & Sons Ltd.,

Dorset House, Stamford St., S.E.1.

Please enter my order for.....copies of the Jan. — June 1958 and the July — Dec. 1958 issues of the ABC GOODS TRANSPORT GUIDE (at 10s. per set). I enclose remittance of.....

NAME.....

ADDRESS.....

A.E.



COLLIER & COLLIER LTD.

NORTH MORETON, DIDCOT, BERKS. - - ENGLAND

Collier's

WORM DRIVE

HOSE CLIP

Phone: DIDcot 2046.

Hundreds of Trades & Professions have a use for them

NESTLER

SLIDE RULES

(MADE IN GERMANY)

AND NOW THEY'RE HERE AGAIN



THE ONLY SLIDE RULE WITH ALL THESE 6 GREAT ADVANTAGES

- ★ Engine divided—durable—non-wearing.
- ★ Body spring loaded against slide.
- ★ Colourfast—cannot change colour with age.
- ★ Unbreakable—long life expectancy.
- ★ Bevel of body utilised as scale—may be used for pencil or ink layout.
- ★ New ineffaceable constant table on plastic label inset on the reverse side assures good legibility.

Obtainable from Drawing Office Dealers and High Class Stationers.

STUDENT MODELS ACCURATE, EFFICIENT

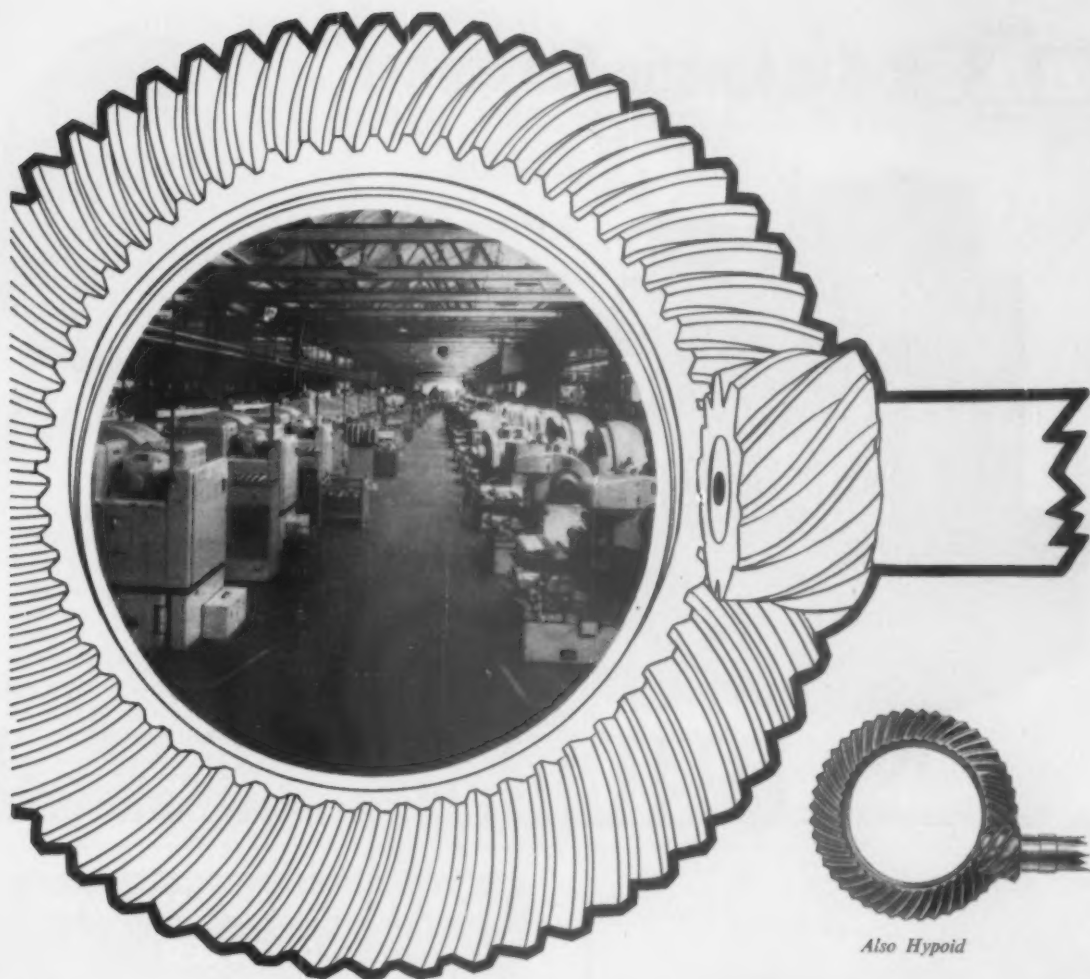
The student models are slightly cheaper and splendid for all student purposes.

In case of difficulty apply:-

W. PATTERSON & CO., LTD.

Beckenham, Kent.
Tel: BEckenham 5023 (7 lines)

NESTLER MEANS PRECISION



SPIRAL BEVEL GEARS

Amongst the largest producers of spiral bevel gears in Europe, we at The Moss Gear Co. have those many years of experience that do so much to smooth away design and production problems. You will find our technical staff happy to work with you—and their advice invaluable.

THE MOSS GEAR CO. LTD • CROWN WORKS • TYBURN • BIRMINGHAM 24

Phone: ERDington 1661-6

Grams: 'Mozgear, Birmingham'

**MOSS
GEARS**

MAS Automatic Die Sinker



for HORIZONTAL ...
VERTICAL ...
MIRROR ...
CIRCULAR ...
SEGMENT COPYING

MODEL FK08c TWO MILLING SPINDLES

Arranged with two
angle plates for
simultaneous re-
production of two
components

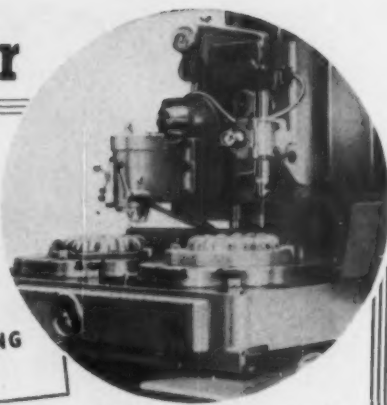


Illustration shows machine copying with
vertical attachment fitted, and using
the two rotary tables.

MODEL FK08b
IMMEDIATE DELIVERY
MODEL FK08c EARLY DELIVERY

CAPACITY

Table, 2 Rotary Tables	27 in. dia.
Longitudinal Table Traverse (automatic)	39 in.
Transverse movement of slide	15 in.
Vertical travel of spindle head	31 in.
Spindle Speeds (R)	70 to 800 or 335 to 3,600 r.p.m.
Feeds (R)	
Longitudinal Table Feed (per min.)	22 in. to 8 in.
Spindle Vertical Feed (per min.)	22 in. to 5 in.
Net weight approx.	9 1/2 tons

EXCLUSIVE
DISTRIBUTORS IN
THE UNITED KINGDOM

ELGAR

Machine Tool Company Limited
172/178 VICTORIA ROAD · ACTON · LONDON · W.3
Phone ACORN 5555 (2 lines) Grams ELGATOL, LONDON, W.3

CALIBRATED JETS

Amal Limited make jet-calibrating machines for checking carburettor petrol jets to conform to British Standard No. 720 of 1948. Amal Limited are equipped to manufacture and calibrate jets from .005" to .5" dia.—all of which discharge a specified flow to within close limits under specified conditions. 'Amal' calibrated jets find many applications for metering the flow of other non-viscous liquids, and also of gases such as town gas, butane, propane, methane, etc.

AMAL

Service to the Motor
and other Industries



AMAL LTD., WITTON, BIRMINGHAM, 6

FOR REALLY RUGGED WORK YOU NEED



... second to none for:—
* Operative smoothness
* Frictional stability
* Long working life

Details and information from —

SMALL & PARKES LTD

HENDHAM VALE WORKS, MANCHESTER 9
COLLYHURST 2311

LONDON OFFICE 76 VICTORIA ST. SW1 VICtoria 1845/6

What is it they
both use — that's made by Laystall?



THE LINK
IS



By courtesy of Messrs. RANSOMES & RAPIER LTD.

Rapier 4½ cu. yd. Truck Mixer. Mixer has Perkins diesel engine fitted with "Cromard" hard chrome liners as standard.

Transport Engineers, Municipal Authorities and Private Motorists the world over are fitting CROMARD the hard chrome cylinder liners that defy cylinder wear. They can be fitted to your engine at the first overhaul and many Manufacturers are fitting them as standard.

Engines—whether petrol or diesel—fitted with CROMARD liners are practically immune from costly premature overhauls and lost working hours, because the life of the entire engine is prolonged.

CROMARD liners are available for most popular engines and the increased demand all over the world especially where roads and working conditions are most difficult is significant.



By courtesy of Timothy Whites & Taylors Ltd.



LAYSTALL ENGINEERING
COMPANY LTD.

Head Office:

53 Great Suffolk Street, London, S.E.1

Telephone: WATerloo 6141

all Laystall Laystall Laystall Laystall La



**THERE
IS NO
END
to the
application of**

MASCO FELT

Your need for Felt may not take the form of Washers, Gaskets or Fabricated Parts (of which we literally make millions) but whatever it is, be sure MASCO can meet it. More than a century of specialised experience . . . manufacturing resources second to none . . . unrivalled modern technical knowledge . . . there's every good reason for the confidence in Masco Felts expressed by Industry the world over.

DO YOU KNOW ALL YOU SHOULD ABOUT MASCO FELT?

Whatever you want to know about Felt—how it can be used to better advantage in your business—put your questions to Masco. We welcome enquiries. Write to-day to Dept. A.E.S.

MITCHELLS, ASHWORTH, STANSFIELD & CO. LTD.

Contractors to H.M. Government

23/24, OLD BAILEY, LONDON, E.C.4.
Phone: City 3606

45, NEWTON STREET, MANCHESTER, 1
Phone: Manchester Central 3503

FOR OVER 100 YEARS FELTMAKERS TO THE WORLD'S INDUSTRIES

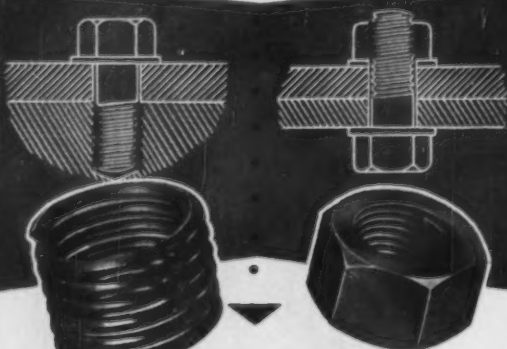


**MADE IN
BRITAIN BY
BRITISH
CRAFTSMEN**

For INCREASED DESIGN SCOPE, USE
OF LIGHTER SECTION MATERIAL, HEAVY
DUTY ASSEMBLY, FREEDOM FROM WEAR,
CORROSION, STRIPPING & MOST OTHER
THREAD TROUBLES . . .

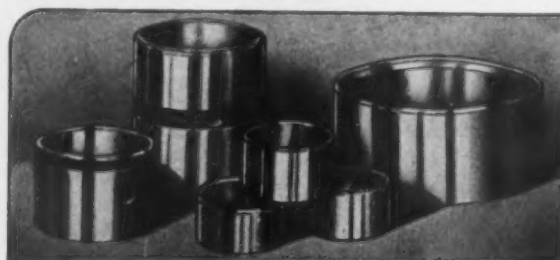
You must have...

HELI-COIL . Heli-NUT
SCREW THREAD INSERTS . HIGH ENDURANCE NUTS



HELI-COIL

Manufactured by:
ARMSTRONG PATENTS CO. LTD • EASTGATE • BEVERLEY • YORKSHIRE



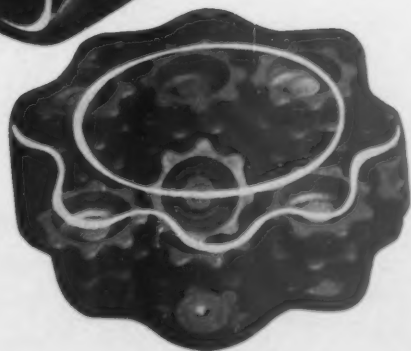
BUSHES

**$\frac{1}{8}$ " TO 10" BORE
HARDENED
AND
GROUND
ALSO
UNHARDENED**

By
The Bush People
SEND US YOUR ENQUIRIES
Established 35 years

LAWRENCE Bros. MILLWARD LTD.
WICKERSLEY
ROTHERHAM

Do you
use drop forgings
like these?



Whether you want a long run or drop forgings in small quantities, do as some of the greatest users of drop forgings—come to Doncasters. Drop forgings that are as good as skilled labour and first class materials and plant can make them are a Daniel Doncaster hall-mark. Discuss your requirements with us.



DANIEL DONCASTER & SONS LIMITED • SHEFFIELD
FORGINGS • DROP FORGINGS • TOOL STEELS • HARDENED STEEL ROLLS

What's yours?

NON-FERROUS CASTING is a specialist field in which experience and facilities are all-important. When you require non-ferrous castings . . . for ordinary or extraordinary purposes . . . specify BIRSO; you'll get the finest there are. The very best cost no more . . . and may well cost far less in the long run.

CASTINGS FROM A FEW OUNCES TO 10 TONS . . .

in phosphor-bronze, gun-metal, aluminium-bronze, manganese-bronze and light alloys. Precision-machined bushes and bearings. Specialists in high-tensile aluminium-bronze castings, centrifugal-cast wheel blanks, and chill-cast rods and tubes.



One of Britain's Largest
NON-FERROUS
Foundries

T. M. BIRKETT, BILLINGTON & NEWTON LTD

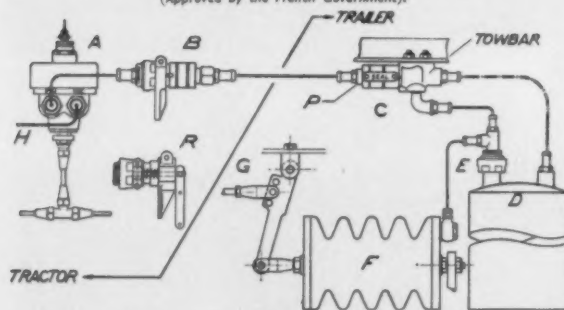
HANLEY AND LONGPORT, STOKE-ON-TRENT

Head Office: HANLEY, Phone: Stoke-on-Trent 22184/5 & 7 LONGPORT, Phone: Stoke-on-Trent 87303



SINGLE LINE PROGRESSIVE BREAKAWAY SYSTEM

(Approved by the French Government).



- A. Hydraulic Reaction Valve L.V. 207 Dual Control, shown fitted to Hydraulic Pipe Line on Tractor.
- B. "C" type Coupling with Auto. Shut-off Valve, attached to rear of Tractor.
- C. Breakaway Valve SBS. 256 (or SBS. 257) attached to Tow Bar of Trailer.
- D. Vacuum Tank on Trailer.
- E. Non-return Valve.
- F. Power Unit on Trailer operating Brakes.
- G. Trailer Brake linkage.
- H. Hose connecting L.V. 207 to source of Vacuum. Hose connections shown as solid lines are those used in normal operation of Brakes. The Hose shown in broken line connects the Vacuum Tank to the Power Unit when Valve "C" is operated in emergency.
- P. Plunger with Safety Seal.
- R. This assembly should be used in place of Coupling "B", when Vacuum Pipe Line operating Trailer Brakes is common to that controlling Brakes on the Tractor.

Existing Trailer can be converted by adding "C", "D" and "E".

FEENY & JOHNSON LTD

134-136, EALING ROAD, WEMBLEY, MIDDLESEX
Tel: WEMBLEY 4801 & 4802 Grams: Feejohn, Wembley

DBB/4840B

Wire THREAD INSERTS

MAKE STRONGER
THREADS UNDER
ANY CONDITIONS
IN ANY MATERIAL
WHETHER FOR
NEW DESIGNS
OR SALVAGE

HARD TOUGH THREADS IN SOFT METALS
NEW THREADS FOR OLD

**CROSS MANUFACTURING
CO. (1938) LTD.**

BATH, SOMERSET

Telephone: COMBE DOWN 2355/8

Telegrams: CIRCLE, BATH



Simms

PUMP AND
EXHAUSTER
COUPLINGS FOR
SILENT FLEXIBILITY

HAVE YOU A COUPLING PROBLEM?

**THE SIMMS CR TYPE
MAY BE THE ANSWER**

1. Backlash and chatter eliminated.
2. Compensates for maximum misalignment.
3. No timing variation through wear.
4. Absolutely silent in operation.

SIMMS MOTOR UNITS LIMITED

OAK LANE, EAST FINCHLEY, LONDON, N.2

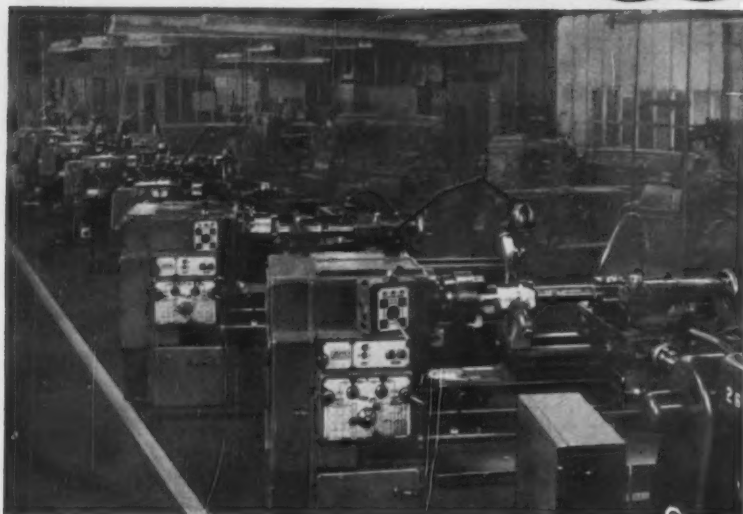
Telephone: HNchley 2262 (20 lines) - Telegrams: Simotunit, Eastfinch, London

AND BRANCHES THROUGHOUT THE COUNTRY

SC16X

NOW STANDARDISING

ON **W & M** LATHES



Westminster Airways Servicing Ltd.

GOSPORT, HANTS.

Since 1951, when they installed their first '70' Junior Lathe, Westminster Airways Servicing Ltd., have steadily added to their W & M line. Today they have five '70' Junior Lathes and two '85' Senior Lathes, all employed "with complete satisfaction" on intricate high precision Aircraft Prototype and Tool Work.

In work of this kind, which demands such high standards of accuracy and reliability, "complete satisfaction" is always the aim of W & M.

WOODHOUSE & MITCHELL

WAKEFIELD ROAD BRIGHOUSE YORKS

PHONE:— BRIGHOUSE 627 (3 LINES)
GRAMS:— 'WOODHOUSE BRIGHOUSE'

WM21

MINIATURE RINGS

... from automatic gear boxes to conveyor rollers Tower Brand Miniature Rings in sizes $\frac{1}{2}$ in. to 2 in. diameter are fitted in an amazing number of varied applications and they are standard equipment in almost all the vehicle suspension dampers manufactured in this country.

The normal Ring material is a close grained Cast Iron, but should particular applications be subject to rusting we produce a special austenitic iron.

Our Technical Department will offer recommendations and quotations against details of your particular needs.

LEEDS PISTON RING & ENGINEERING CO. TEL. 31113
Goodman St, Hunslet, Leeds. 10.



There's no limit to the versatility of **RICHARDS** Precision Repetition Machining

We are equipped for machining on Single and Multi Spindle Autos from $\frac{1}{8}$ " to 3" diameters in Free Cutting Mild Steel, Brass, Alloy Steels, etc., Turning, Milling and Grinding capacity available.



CHARLES RICHARDS & SONS, LTD.,
Imperial Bolt and Nut Works, Darlaston, Nt. Wednesbury.
Phone: James Bridge 3188 (8 lines) P.B.X.
Wires: "Richards" Darlaston.

GLOUCESTER

TOUGH AND RIGID YET EASY TO MACHINE

Gloucester Blackheart Malleable castings are widely used throughout the automobile, railway and farm machinery industries.

The new elevator-type electric furnace anneals in 48 hours! - instead of the usual 7 days. It also allows greater control of the component during annealing, resulting in uniformity of metal, greater strength and resistance to impact, and a smoother,

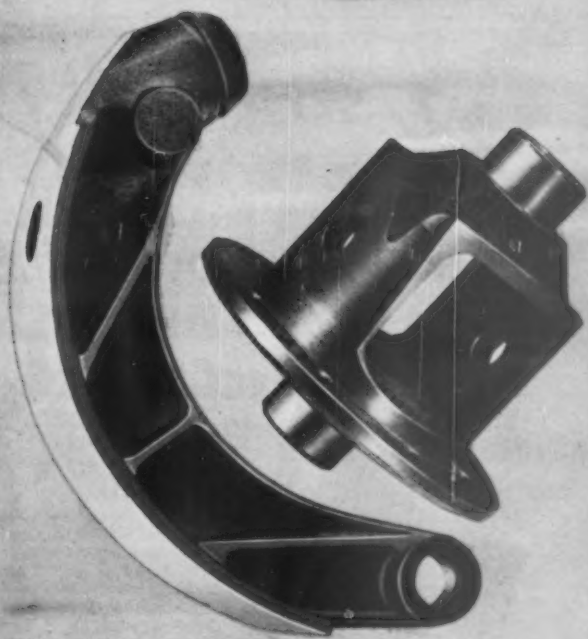
malleable & grey iron castings

finer skin. Machining time is therefore reduced to a minimum. Every heat is under constant laboratory control throughout the day and castings are rigidly inspected at every stage of production.

Gloucester technicians will gladly advise on the design of malleable or grey iron castings. Why not call them in at the drawing board stage?

Typical Gloucester Malleable specifications are:

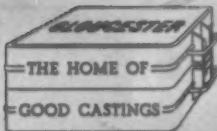
Gloucester Blackheart Malleable		Gloucester Lamellar Pearlitic Malleable	
Elongation	18%	Elongation	5%
Yield Point	15 tons	Yield Point	22 tons
Tensile strength	25 tons p.s.i.	Tensile strength	35 tons p.s.i.



(right) Differential cage for motor vehicle in Malleable Iron.

(left) Brake Shoe in Malleable Iron.

GLOUCESTER FOUNDRY LTD., EMLYN WORKS, GLOUCESTER
(A subsidiary of the Gloucester Railway Carriage & Wagon Co. Ltd.)



Telegrams: 'Pulleys' Gloucester
Telephone: Gloucester 23041

JMS

Thiokol

*REGD. TRADE NAME

LIQUID POLYMER FOR COLD CASTING COMPOUNDS

Thiokol Liquid Polymer Type LP-2 is a solventless liquid that is poured and cured cold and does not undergo dimensional change during handling. It cures to a Resilient Rubber.

USED: For casting seals and gaskets in place on various types of machinery; potting electrical and electronic components; in the manufacture of printing rollers and large detailed relief maps.

Write Dept. NO/7 for full technical details.

J. M. STEEL & CO. LTD.

LONDON: 36-38 Kingsway, W.C.2 Tel.: HOLborn 2532/5

MANCHESTER: 51 South King Street, 2 Tel.: Deansgate 6077/9

BIRMINGHAM: 45 Newhall Street, 3 Tel.: Central 6342/3



May we do your pressing?

For hot pressings and stampings—accurate well-finished and of consistently high quality—come to Sutcliffe Speakman. We undertake machining where necessary and can work to limits down to .0005". No quantity is too large, no job too complicated, no standard too exacting.



SUTCLIFFE
SPEAKMAN



In non-ferrous alloys including aluminium, brass, chromium-copper, cadmium-copper, manganese bronze and nickel silver. Also castings in gun-metal, phosphor bronze and heat-resisting nickel chrome alloys.

SUTCLIFFE SPEAKMAN & CO. LTD. · Leigh · Lancashire · Tel: Leigh 94
London Office: 2 CAXTON STREET, WESTMINSTER, S.W.1. TEL: ABBEY 3085

Cut SET-UP COSTS!



Change to ROCKWELL HELICAL CLAMPS

BRITISH PATENT

Why waste time building up rickety, makeshift clamps with anything that's handy? Get on the phone today and ask for full information about Rockwell Helical Clamps. These ingenious clamps have been designed for simple quick and positive mounting, with negligible clamp projection over work piece. Each clamp is a complete unit, with no parts to lose.

ALL SIZES
DELIVERED
EX-STOCK

• WRITE OR PHONE FOR LEAFLET GIVING PRICES
SIZES AND FULL TECHNICAL DETAILS
-TODAY!

WELSH HARP, EDGWARE ROAD,
LONDON, N.W.2. GLADstone 0033

ROCKWELL
MACHINE TOOL CO. LTD.

Also at
Birmingham—Springfield 1134/5. Stockport—Stockport 5241. Glasgow—Merrylee 2822



what are you waiting for?

You want Precision Hobs? We can supply them! Spur, helical, worm wheel, spline or serration, made precisely to your requirements.

Our standard Spur and Helical range is designed to cover all normal requirements and to give you speedy deliveries, in many cases actually from stock.

If you have not been using David Brown Precision Hobs, write now for Leaflet E313.9 and get yourself acquainted with our quality and our service.

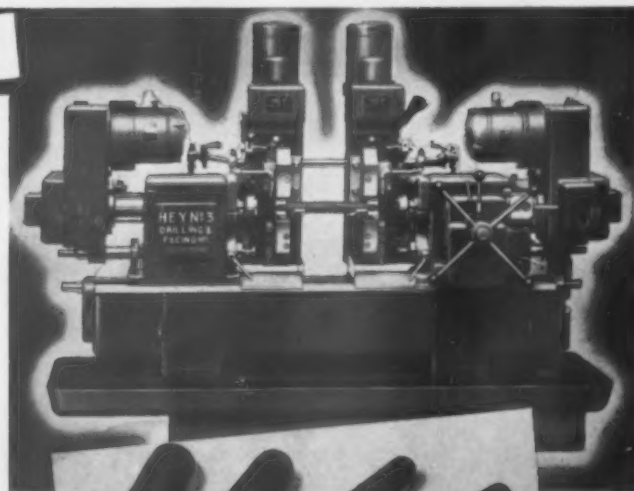
THE DAVID BROWN
CORPORATION (SALES) LIMITED
TOOL DIVISION
PARK WORKS HUDDERSFIELD

130 SHAFTS FACED AND CENTRED PER HOUR

Facing $\frac{1}{8}$ " off each end and drilling $\frac{7}{16}$ " centres in $2\frac{1}{2}$ " diameter Electric Motor Shafts in a floor to floor time of 27 seconds, is typical of the high production which can be achieved on the —

HEY No. 3 DOUBLE ENDED CENTRING & FACING MACHINE

- Perfect alignment of centres
- True faces and accurate lengths
- Turned finish on faces
- Eliminates subsequent facing down to centres or recentring

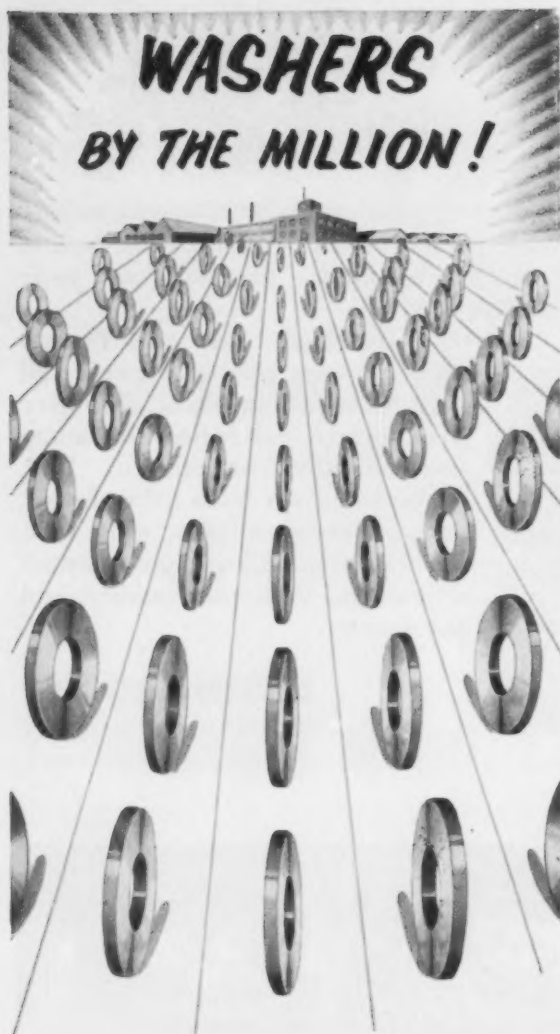


ENGINEERING CO. LTD.
COVENTRY PHONE COVENTRY 88641

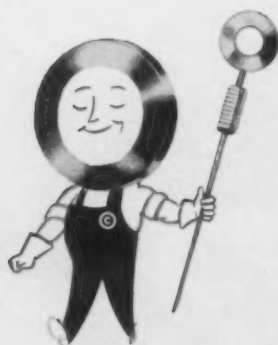
We also manufacture Rotary Cam and Profile Milling Machines, Short Thread Milling Machines, Multiple Drilling Heads and Machines, Tapping Machines, Gear Tooth Rounding Machines, Special Machine Tools for High Production.

Faces 3" diameter. Standard Vices have maximum bar capacity of $6\frac{1}{2}$ " diameter. Minimum length handled 6". Standard bed lengths to take work up to 24", 48" or 72" long.

Rambow

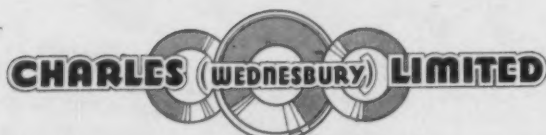


WASHERS BY THE MILLION!



Manufacturers of :

- BRIGHT STEEL AND BRASS TURNED AND CHAMFERED WASHERS
- PLAIN BRIGHT STEEL AND BRASS WASHERS
- STEEL AND BRASS B.A. WASHERS
- ROOFING WASHERS
- ENGINEERS' BLACK WASHERS
- Odd Sizes a Speciality!



BRIDGE WORKS • WEDNESBURY • STAFFS

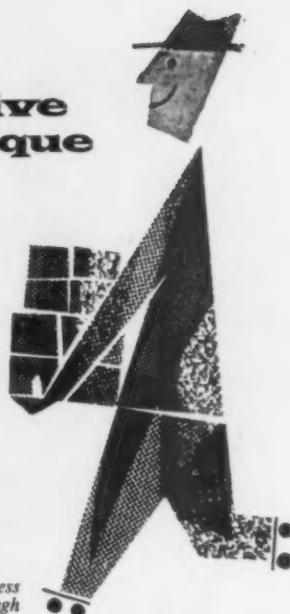
Telephone: WEDnesbury 0544-5 Telegraphic Address: "Chamfer Wednesbury"

progressive technique

The progressive man who wants to push ahead can extend his technical knowledge by wider reading. Let SMITH'S supply you with all the books you need to keep abreast with the latest developments in automobile design and construction.

Volumes not in stock can be obtained for you, and we shall be pleased to supply a list of standard works on any subject.

- You can also obtain your business and personal stationery through our local branch.



W. H. SMITH & SON

HEAD OFFICE : STRAND HOUSE, LONDON, W.C.2

BRANCHES THROUGHOUT ENGLAND AND WALES



**BUT IT'S
BETTER TO
INSTALL UDAL
PRESS GUARDS**

Many a pressworker exposes himself to danger because the guard slows him down, irritates him, frustrates him. That's one good reason for fitting Udal 'Fastrap' guards. Guard and clutch are synchronised to ensure split-second timing, allowing the highest standard of safety without impeding production. Send for details today.

J. P. UDAL LIMITED
INTERLOCK WORKS, COURT RD.,
BIRMINGHAM 12. TEL: CAL 3114



For quicker and more economical assembly

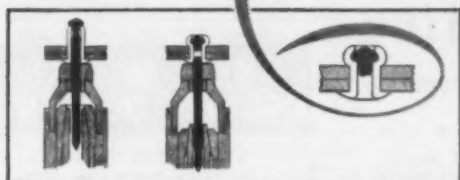
In constant use where speed, economy and simplicity are essential, the "Pop" Riveting System is solving assembly problems in an ever-increasing range of industries.

Almost limitless in its applications, it requires only one operation by one operator, working from one side of the material only, to set or clench the rivet, thereby enabling rivets to be set in positions inaccessible by other methods.

Our technical staff will be pleased to co-operate in solving your assembly problems.



The illustration above shows "Pop" Rivets being used attaching springs for holding moulding finishers—just one of the many applications in the motor industry.



TUCKER POP RIVETS

Geo. **TUCKER EYELET** Co. Ltd.
Walsall Road . . . **BIRMINGHAM 22**

Telephone: BIRchfields 5824 (7 lines)

Telegrams: EYELETS, BIRMINGHAM

Consultants: **AIRCRAFT MATERIALS LTD.** Midland Road, London, N.W.1

"POP" is a regd. Trade Mark of Geo. Tucker Eyelet Co. Ltd.



STAINLESS STEEL SHEETS AND BARS

Why burden yourself
with large stocks

go to **CASHMORES**

for 'off-the-shelf' delivery

BRITISH MATERIAL ONLY

One of the largest STAINLESS STEEL STOCKHOLDERS in the country,
COMPETITIVE PRICES • SEND FOR STOCK LIST

JOHN CASHMORE LTD
GT. BRIDGE • TIPTON • STAFFS. Tel. Tipton 2181/7

CLASSIFIED ADVERTISEMENTS

RATE 4d. per word, minimum 4/- Each paragraph charged separately. Box number 5 words—plus 1/- Advertisements for the February, 1958, issue should be to hand not later than first post 28th January. No responsibility accepted for errors.

PATENTS

PATENT No. 713228—New or Improved Switch Arrangement for Actuating Signalling Devices on Motor Vehicles.

THE Proprietors of Patent No. 713228 desire to enter into arrangements, by way of licence or otherwise, on reasonable terms to ensure its full development and commercial working in this country.

ADDRESS enquiries to:—W. P. Thompson & Co., Chartered Patent and Trade Mark Agents, 12 Church Street, Liverpool, 1. [5606]

PATENT No. 706147—Improvements in Steering Wheels.

THE Proprietors of Patent No. 706147 desire to enter into arrangements, by way of licence or otherwise, on reasonable terms to ensure its full development and commercial working in this country.

ADDRESS enquiries to:—W. P. Thompson & Co., Chartered Patent and Trade Mark Agents, 12 Church Street, Liverpool, 1. [5607]

PATENT No. 706276—Improvements in or Relating to Steering Wheel Switches for Motor Vehicles.

THE Proprietors of Patent No. 706276 desire to enter into arrangements, by way of licence or otherwise, on reasonable terms to ensure its full development and commercial working in this country.

ADDRESS enquiries to:—W. P. Thompson & Co., Chartered Patent and Trade Mark Agents, 12 Church Street, Liverpool, 1. [5608]

PATENT No. 714116—New or Improved Contact Device for Conveying Current to Electrical Switches in Motor Vehicles.

THE Proprietors of Patent No. 714116 desire to enter into arrangements, by way of licence or otherwise, on reasonable terms to ensure its full development and commercial working in this country.

ADDRESS enquiries to:—W. P. Thompson & Co., Chartered Patent and Trade Mark Agents, 12 Church Street, Liverpool, 1. [5609]

THE Proprietor of British Patent No. 692114, for "Improvements in and Relating to Control Means for Clutches in Motor Vehicles," desires to enter into negotiations with a firm or firms for the sale of the patent, or for the grant of licences thereunder. Further particulars may be obtained from Marks & Clerk, 57 and 58 Lincoln's Inn Fields, London, W.C.2. [5611]

SERVICES OFFERED

DESIGN Office Capacity available for Mechanical and Production Engineering. Special Machines and Projects. Norris Brothers Ltd., 53 Victoria Street, London, S.W.1. Tel.: Abbey 5444. [5610]

TUITION

A.M.I.M.L. City and Guilds, A.M.I.Mech.E., etc., on "No Pass-No Fee" terms. Over 95% successes. For details of Exams. and Courses in all branches of Auto., Aero., Mechanical Eng., etc., write for 144 page handbook—Free. B.I.E.T. (Dept. 643), 29 Wright's Lane, W.8.



For automatic and capstan precision parts—in any metal—to your own specifications... consult the specialist machinists.

I.F.V., D.A.I., D.I.Arm., A.R.B. Fully Approved.

REPETITION PARTS from the BAR by

Telephone: Broadwell 1115 (4 lines) and 1757



M.C.L. & REPETITION LTD.

POOL LANE · LANGLEY · BIRMINGHAM

COTTON BAGS

FOR SPARE PARTS Etc.

Walter H. Feltham & Son Ltd

Imperial Works, Tower Bridge Road

Telephone: HOP 1784 LONDON, S.E.1



ALL TYPES OF BOLTS, NUTS, SCREWS & STUDS FOR ENGINEERING.

ALTRINCHAM ST.

MANUFACTURERS

London Representative: Tel ARDUICK 1765

W. KELWAY-BAMBER & CO LTD

9, VICTORIA STREET, S.W.1. Tel. ABBEY 6860

dm SM 36

STEEL SHELVING

100 Bays of Brand New Adjustable Steel Shelving 72" high x 34" wide x 12" deep: stove enamelled bronze green; sent knocked down, six shelf bay £3 15s.

Sample delivered free. Quantity discounts.

N. C. BROWN LTD.,

Eagle Steelworks, Heywood Lancs. Tel. 69018.

NEW BALL & ROLLER BEARINGS

OVER 4,000,000 IN STOCK IN MORE THAN 4,000 TYPES

BRITAIN'S LARGEST STOCKS

WRITE FOR NEW STOCK LIST

CLAUDE RYE BEARINGS

895-921 FULHAM ROAD, LONDON, S.W.6

TELEGRAMS: CLAUDE RYE BEARINGS, LONDON. TELEFON: 2361

MECHANICAL ENGINEERS

FOR

MOTOR VEHICLE TECHNOLOGY

The Associated Ethyl Company Limited has vacancies at its Engine Laboratory, Bletchley for Mechanical Engineers for experimental work on Motor Vehicle and Engine Testing. Applicants should be University Graduates or Associates of a Corporate Institution. However, consideration may be given to candidates who have not the qualifications but are of equivalent standard and have had suitable experience.

Some assistance may be given to married men towards helping them change their location. The Engine Laboratory is situated in pleasant rural surroundings close to the development town of Bletchley. Transport is available to and from the Engine Laboratory and there is a Company Operated Pension Scheme.

Applications should be sent to:—

The Manager, The Associated Ethyl Company Limited, Engine Laboratory, Watling Street, Bletchley, Bucks.

Young men with experience and initiative in Car Design are invited to apply for the following vacancies:

CHIEF DRAUGHTSMAN (Chassis)
ASSISTANT CHIEF DRAUGHTSMAN (Body)
CHECKER/SENIOR DESIGNER (Chassis)
SENIOR LAYOUT BODY DESIGNER

These positions are with a well-known automobile manufacturer in the Midlands. Salaries dependent on experience, personal qualities and age. Positions are supernumerary and hold prospects for the right men together with security for the future. Applications quoting C.R. to the Technical Personnel Manager, Armstrong Siddeley Motors Limited, Coventry.

MEKELITE



For wall, bench or machine mounting.

Catalogue sent free on request

MEK-ELEK Engineering Ltd.

17 Western Road MITCHAM Surrey.

MITCHAM 3072

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(Faculty of Technology in the University of Manchester)

GRADUATES WITH AN INTEREST IN ELECTRONICS are invited to apply for the post of Lecturer in the Department of Textile Industries with the title and status of Lecturer in the University of Manchester.

The salary will be on the scale £900-£1,650, according to qualifications, with superannuation under the F.S.S.U., and family allowances.

The Department has excellent research facilities and members of the staff are expected to undertake and supervise research. University regulations permit teaching staff to read for the degrees of M.Sc.Tech. and Ph.D.

A knowledge of experimental stress analysis is desirable, textile experience is not essential.

Conditions of appointment and an application form may be obtained from: The Registrar, The Manchester College of Science and Technology, Manchester, 1. The last day for the receipt of applications is March 1st, 1958. Applications by airmail (no forms) will be considered from overseas candidates.

B. V. BOWDEN, Principal of the College.

FLEXIBILITY...

★
that only **DOUBLE PROCESSED CREPED PAPER TAPE** can give

Sellotape CREPED PAPER Masking

Tapes meet all requirements of product finishing or special processing

INCLUDED IN THE SELLOTAPE RANGE:

No. 51 STANDARD

For most spraying work. Thin but extremely strong, ideal for masking sharp curves. Temperature-resistant up to 200°F for up to 2 hours—to 250°F for shorter periods. Non-discolouring on most painted and enamelled surfaces.

No. 575 HIGH TEMPERATURE

For stoving and drying processes. Adhesive remains firm up to 266°F for 12 hours.

No. 52 WAFER THIN

As No. 51 Standard, but extra thin and flexible. Prevents paint build-up.

No. 46

Specially designed for protection of rubber surfaces. Can be removed without leaving deposit after stoving up to 212°F.

For heavy duty masking and protection

Sellotape Cloth tapes

For resistance to chemical action

Sellotape Polythene tapes



Sellotape

REGD TRADE MARK

MASKING TAPES

perfect start to a perfect finish

Sellotape is the Registered Trade Mark of Adhesive Tapes Ltd.



Sole Distributors in the U.K.—The INDUSTRIAL SELLOTAPE DIVISION of Gordon & Gotch Ltd., 8-10 Paul Street, London, E.C.2. Telephone: BISHOPSGATE 6511

© & ©

AUCTIONEERS & VALUERS OF PLANT, MACHINERY AND FACTORIES

SINCE 1807

FULLER HORSEY

SONS & CASSELL

10, LLOYD'S AVENUE · LONDON · E.C.3. Phone ROYAL 4861

Rushmore



TOP DOG

WITH PRECISION MADE **HAND TOOLS**

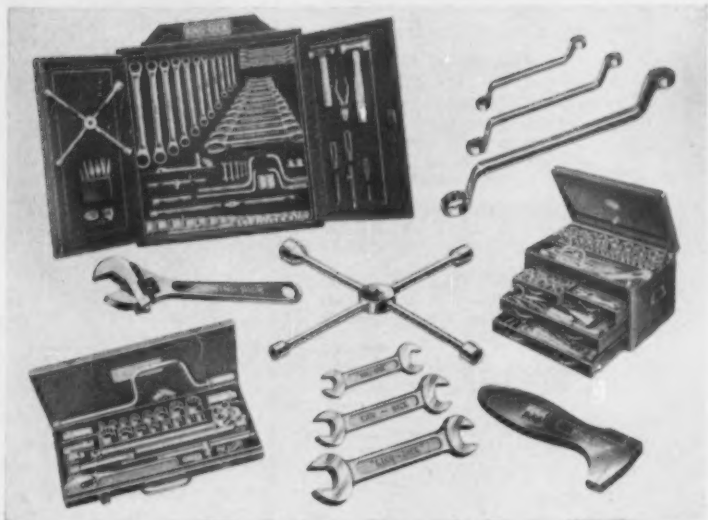
... Equip with KING DICK, the hand tools with the tradition of constant quality, superb design and excellent finish.

From the largest Constructional Engineering Tools to the smallest B.A. Socket Set, KING DICK inspection routine ensures the correct combination of selected steels, perfect balance and precise accuracy.

BUY  **BRITISH!**

ABINGDON
KING DICK

ABINGDON WORKS • KINGS ROAD
TYSELEY • BIRMINGHAM • 11



R/E 201

INDEX TO ADVERTISEMENTS

PAGE		PAGE		PAGE		PAGE	
A.B.C. Goods Transport Guide	90	Clayton-Wright, Howard, Ltd.	39	Hey Engineering Co. Ltd.	101	Pioneer Oilsealing & Moulding	52
Abingdon King Dick Ltd.	106	Collier & Collier Ltd.	90	High Duty Alloys Ltd.	63	Co. Ltd.	
Acrow (Engineers) Ltd.	36	Consolidated Pneumatic Tool		Hoffmann Manufacturing Co.		Ransome & Marles Bearing Co.	
Adamant Engineering Co. Ltd.	60	Co. Ltd.	Cover iii	Ltd., The	45	Ltd.	16
Aluminium Bronze Co. Ltd.	86	Cork Manufacturing Co. Ltd.	30	Holroyd, John, & Co. Ltd.	11	Renold Chains Ltd.	35
Amal Ltd.	92	Coventry Motor Fittings Co.		I.C.I. (Isocyanates) Ltd.	61	Reynolds T.I. Aluminium Ltd.	51
Archdale, James, & Co. Ltd.	87	Ltd.	25	I.C.I. (Metals) Ltd.	76	Richards, Chas., & Sons Ltd.	98
Armstrong Patents Ltd.	94	Courtaulds Ltd.	69	Ilford Ltd.	4	Rockwell Machine Tool Co.	
Armstrong - Siddeley Motors		Cross Mfg. Co. (1938) Ltd.	96	Jackson, H., Ltd.	23	Ltd.	100
Ltd.	104	Danly Machine Specialties Inc.	55	Kayser Ellison & Co. Ltd.	20	Rye, Claude, Ltd.	104
Armstrong Whitworth & Co.		Dartmouth Auto Castings Ltd.	70	Kirkstall Forge Eng. Ltd.	62	Salter, Geo., & Co. Ltd.	34
(Pneumatic Tools) Ltd.	18	Desoutter Bros. Ltd.	54	Lawrence Bros. Millward Ltd.	94	Sandwell Casting Co.	88
Associated Ethyl Co. Ltd.	104	Doncaster, Daniel, & Sons		Ltd.	93	Selson Machine Tool Co.	
Atlas Copco AB	Cover ii	Drummond - Asquith (Sales)	95	Ltd.	93	Ltd.	42
Automotive Engineering Ltd.	77	Ltd.	9	Laystall Engineering Co. Ltd.	48	Sheffield Twist Drill & Steel	
Automotive Products Co. Ltd.	5, 6, 7, 8	Elgar Machine Tool Co. Ltd.	92	Lee, Arthur, & Sons Ltd.	80	Co. Ltd., The	57
Barber & Colman Ltd.	84	Feeny & Johnson Ltd.	96	Leeds Piston Ring & Engineer-	98	Silentbloc Ltd.	13
Benton & Stone Ltd.	22	Ltd.	104	ing Co. Ltd.	79	Simms Motor Units Ltd.	97
Birkett, Francis W., & Sons		Feltham, Walter H., & Sons	40	Linread Ltd.	80	Skefko Ball Bearing Co. Ltd.	72
Ltd.	78	Ferodo Ltd.	33	Litchfield Bros. Ltd.		Small & Parkes Ltd.	92
Birkett, T. M., Billington &		Firth-Brown Tools Ltd.	41	Manchester College of Science	104	Smith, W. H., & Son	102
Newton Ltd.	96	Firth-Derihon Stampings Ltd.,	33	and Technology	104	Steel, J. M., & Co. Ltd.	100
Birlec Ltd.	15	The	41	Marsden, Samuel, & Son Ltd.	104	Steels Engineering Products	
Birmingham Aluminium Casting		Firth, Thos., & John Brown	24	M.C.L. & Repetition Ltd.	104	Ltd.	50
(1903) Co. Ltd.	Cover iv	Ltd.	83	Mek-Elek Engineering Ltd.	104	Sterling Metals Ltd.	26
Bound Brook Bearings Ltd.	32	Firth-Vickers Stainless Steels	24	Metalastik Ltd.	29	Sutcliffe, Speakman & Co.	100
British Oxygen Co. Ltd., The	67	Ltd.	84	Metropolitan Plastics Ltd.	75	Ltd.	
British Piston Ring Co. Ltd.,		Fischer Bearings Co. Ltd.	Cover i	Midland Motor Cylinder Co.	66	Teddington Industrial Equip-	84
The	65	Fletcher Miller Ltd.	80	Ltd., The	94	ment Ltd.	
British Thomson-Houston Co.		Fuller, Horsey, Sons & Cassell	105	Mitchells, Ashworth, Stansfield	94	Terry, Herbert, & Sons Ltd.	28
Ltd.	88	Funditor Ltd.	53	& Co. Ltd.	38	Toledo Woodhead Springs Ltd.	49
Broom & Wade Ltd.	64	Gear Grinding Co. Ltd., The	68	Morgan Crucible Co. Ltd.,	91	Torrington Co. Ltd., The	85
Brown, David, Corporation		General Electric Co. Ltd., The	82	The	12	Triplex Foundry Ltd.	86
(Sales) Ltd., The	1, 81, 101	Gill's Cables Ltd.	78	Moss Gear Co. Ltd.	90	Tucker, George, Eyleet Co.	
Brown, N. C.	104	Girling Ltd.	79	Newall, A. P. & Co. Ltd.	47	Ltd.	103
B.S.A. Tools Ltd.	43	Gloucester Foundry Ltd.	105	Nestler Slide Rules	17	Udal, J. P., Ltd.	102
Burton Griffiths & Co. Ltd.		Gordon & Gotch Ltd.	105	Neill, Jas., & Co. (Sheffield)	90	Vaughan Associates Ltd.	3
Cape Asbestos Co. Ltd., The	58, 59	Guest, Keen & Nettlefolds	89	Ltd.	2	Ward, H. W., & Co. Ltd.	76
Cashmore, John, Ltd.	103	(Midlands) Ltd.	31	Osborn, Samuel, & Co. Ltd.	88	Ward, Thos. W., Ltd.	98
C.A.V. Ltd.	46	Harper, John, & Co. Ltd.	10	Parker Packing Co. Ltd., The	44	West Yorkshire Foundries Ltd.	56
Charles (Wednesbury) Ltd.	102	Hecna & Froude Ltd.	21, 37	Pell, Oliver, Control Ltd.		Wild-Barfield Electric Furnaces	
Clancey, G., Ltd.	82	Herbert, Alfred, Ltd.		Philidas Div. of Whitehouse		Ltd.	27
Clayton Dewandre Co. Ltd.	14			Industries Ltd.			

Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1, by James Cond Ltd., Charlotte Street, Birmingham 3. "Automobile Engineer" can be obtained abroad from the following: AUSTRALIA & NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd.; Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd.; Wm. Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Co. Entered as Second Class Matter at the New York, U.S.A., Post Office.



**CONSOLIDATED
PNEUMATIC
MAKE OVER 480
DIFFERENT MODELS
OF POWER TOOLS**

Here are two C.P. AERO RIVETERS

*THE LONG AND SHORT OF
A GOOD JOB DONE QUICKLY*



Consolidated Pneumatic

C.P. Aero Riveters have a special appeal for all industries concerned with fabrication in light alloys. Their finely controlled, slow hitting heavy blows give just the right impact to form a rivet without excessive work-hardening or damage to the surrounding metal. Also in the range are one shot (as illustrated top) riveters, compression and squeeze type riveters, and hammers, to meet a variety of conditions. Write for the Riveters section of catalogue 50C.

CONSOLIDATED PNEUMATIC TOOL CO. LTD., 232, DAWES ROAD, LONDON, S.W.6

AIR COMPRESSORS • PNEUMATIC TOOLS • ELECTRIC TOOLS • CONTRACTORS EQUIPMENT • ROCK DRILLS • PUMPS • DIAMOND DRILLS

plan
with
Birmal



Air intake casing
for the Proteus engine.
By courtesy of The Bristol
Aeroplane Company Limited.

You get more than a casting from



This is a casting. A very exclusive casting. Its life—in flying hours—is far more certain than the life of any human being. How is such certainty attained? Where does it begin? Surely, with the materials used, and with the men who fashion them? It begins with accuracy, consistency and foundry 'know-how'. Where light alloy castings for the Aircraft Industry are concerned, it is not too much to say that certainty begins with Birmal.

Birmingham Aluminium Casting (1903) Co. Ltd.

BIRMID WORKS SMETHWICK BIRMINGHAM 40